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ABSTRACT

The purpose of this booklet is to articulate the student outcomes expected for children in grades K-12. This document seeks to reflect the major themes of science education. These common curriculum goals have been developed not to detail separate facts of science needed to be taught by every science program, but to detail a larger view of the same subject around which the facts deemed important by each individual program can be organized. The concepts and processes of the seven common curriculum goals serve as the primary organizers, unifying Oregon's approach to the learning of K-12 science. The seven strands of this curriculum include: (1) concepts; (2) processes; (3) manipulative skills; (4) interests; (5) values; (6) interactions; and (7) characteristics. The student objectives in each content strand include the essential learning skills deemed appropriate for science instruction and the common knowledge skills unique to science. Because concepts and processes are learned best in various contexts and in multiple experiences, they are pyramidical throughout the K-12 continuum. A brief list of resources is appended. (CW)

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SCIENCE

Comprehensive Curriculum Goals
A Model for Local Curriculum Development

June 1989

Oregon Department of Education
700 Pringle Parkway SE
Salem, OR 97310-0290

Verne A. Duncan
State Superintendent of Public Instruction

Oregon Schools--A Tradition of Excellence

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FOREWORD

In June 1984 the State Board of Education adopted the Oregon Action Plan for Excellence which established the direction for school improvement in the state over the next decade. The Action Plan drew upon the insights of teachers, administrators, school board members and community and business leaders.

A central concept of the Action Plan is that while the state will determine WHAT must be taught in public schools, the schools will determine HOW it will be taught. This document is intended to provide the essential information which local districts need to merge state curriculum expectations with their own local determinations for Science Education.

All who have joined in the spirit of the Action Plan for Excellence have shared a commitment to high-quality performance. We are continuing to learn about how to provide children with the very best in public education, and we welcome your comments and questions. For further information about this guide, contact the specialist for Science Education, 373-7898.

Verne A. Duncan
State Superintendent
of Public Instruction

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INTRODUCTION

THE OREGON ACTION PLAN FOR EXCELLENCE

The Action Plan identified seven areas of improvement, one of which called for a statewide definition of what students should learn:

> The Oregon Department of Education, working with local school districts and higher education institutions, shall define the required ***common curriculum goals*** for elementary and secondary schools in terms of the learning skills and knowledge students are expected to possess as a result of their schooling experience.
>
> Local school districts, with assistance from the Oregon Department of Education, shall be responsible for organizing the curriculum and delivering instruction to achieve the ***common curriculum goals***.

Common Curriculum Goals

The first stage in defining the Common Curriculum Goals was to develop the ***Essential Learning Skills*** -- the basic skill and performance expectations for all students in the areas of reading, writing, speaking, listening, mathematics, reasoning and study skills. The second stage is to develop Common Knowledge and Skills in individual subject areas. Together with the ***Essential Learning Skills***, they form the Common Curriculum Goals for all students.

A. Essential Learning Skills

The ***Essential Learning Skills*** are considered basic to all students' learning, and all teachers are expected to provide instruction in these skills. Only to the degree that students develop these skills and form the habit of using them, can instruction in subject matter areas be successful. The skills are not specific to any one discipline but provide a link across all disciplines. Furthermore, the skills do not grow in isolation from content; they are strengthened through practice and use in all subject areas.

B. Common Knowledge and Skills

Looking beyond the ***Essential Learning Skills***, this document defines more fully what are considered to be the essentials in a strong Science Education program. Each district will want to extend and elaborate upon this base in order to create its own unique, comprehensive Science Education curriculum. Students should have the opportunity to demonstrate their achievement in a variety of ways. Equal opportunity to learn and the special needs of students are primary considerations in determining acceptable performance levels.

State Standards

The Common Curriculum Goals as presented in this document receive their authority from the Oregon State Standards for Public Schools, OAR 581-22-420 and 581-22-425. These rules were amended by the State Board of Education in January 1986.

PHILOSOPHY/RATIONALE UNDERLYING THIS CURRICULUM

Science is a process of building internally consistent conceptual models which help us make sense of the natural world. It looks for patterns and regularities to help us understand our environment. The process rests upon a cumulative base of interrelated ideas which help explain our observations of natural phenomena. It requires a questioning attitude and progresses by way of skills and processes such as collecting, organizing and interpreting information. Science involves challenging existing ideas and resolving problems which arise when our ideas fail to explain all the "facts" we observe. Science by its very nature is an unfinished enterprise.

The rationale for including science as a critical component of the school curriculum in all grades is linked to the foregoing definition of science. At a personal level, competence in science gives individuals confidence to respond intelligently to objects and events of nature and to control some aspect of their personal environment and destiny. At a societal level, overall competence in science is necessary to assure ethical stewardship of our planet and the human condition. Science education must help students to understand and, indeed, shape the ways in which science will affect the future quality of life. Why teach science? The major reason is to develop environmentally, scientifically, and technologically literate members of society.

There are recognized attributes that describe a scientifically and technologically literate person. Each attribute should be thought of as describing part of a continuum along which the individual may progress. The progress of the individual's science education should be equated with progress along this continuum. In 1972, Paul DeHart Hurd identified four major purposes of science education. The 1983 National Science Teachers Association position statement Science-Technology-Society: Science Education for the 1980s pushed for a new thrust in science education to emphasize goals which relate science to society and technology. Hurd's purposes are congruent with those of NSTA and Simpson, R.D. and Anderson, N.D., 1981, who describe their concept of the scientifically literate person:

- Has knowledge of the major concepts, principles, laws and theories of science and applies them in appropriate ways.
- Uses the processes of science in solving problems, making decisions and in other suitable ways.
- Understands the nature of science and the scientific enterprise.
- Understands the partnership of science and technology and its interaction with society.
- Has developed science-related skills that enable him or her to function effectively in careers, leisure activities and other roles.
- Has developed interests that will lead to a richer and more satisfying life and a life that will include science and life-long learning.

Clearly, scientific literacy cannot be pursued in isolation from other branches of thought and academic pursuit. Indeed, the strong relationships of science to language arts, mathematics, social studies and other areas indicate the value of integrated treatment of science with other curricular areas. The same "hands on" science activities that promote intellectual development during early school years simultaneously serve the development of reading, mathematical and social skills. Therefore, another answer to "Why teach science?" resides in the potential of science education to complement other curricular areas. This complementarity can exist

through all school years. If carefully planned, integration of science with other subjects will also promote more efficient use of time in school.

In a world community which is increasingly competitive in producing scientific and technological goods and services, it is increasingly important to address ways in which science education may affect, directly and indirectly, both national concerns and individual career and leisure activities. Scientific literacy is needed for both the future scientists who will directly contribute to science nationally and internationally and the citizens who will indirectly shape the future course of science. A strong, sustained effort in science education is necessary to assure individual, national and international wellbeing.

The difficulties of improving and maintaining good science has led to the view that science education is in a state of crisis. By 1983, a wave of educational reform reports generated interest, support and funds for the improvement of education. In science, such studies clearly established that the average student using National Science Foundation (NSF) curriculum materials of the 1960s outperformed 63% of the students in traditional textbook courses. Since current science teaching is marked by the almost total reliance on textbooks, reform efforts have again sought to identify programs which identify the fundamental knowledge, concepts and processes of science which make it accessible to all students.

As a result, this document seeks to reflect the major themes currently recommended by science education. The Science Common Curriculum Goals have been developed not to detail separate particulate facts of science needed to be taught by every science program, but to detail a larger view of the same subject around which the facts deemed important by each individual program can be organized. The concepts and processes (CCGs 1.0 and 2.0) of the seven Science Common Curriculum Goals serve as the primary organizers, unifying Oregon's approach to the learning of K-12 science. Since the concepts and processes require internal, cognitive development, teachers cannot teach them directly but must facilitate their development. And, because they are also learned best in various contexts and in multiple experiences, they are pyramided throughout the K-12 continuum. Concrete (hands-on) experiences have been found critically important for almost all students in nearly all settings. The laboratory, including safe and humane practices as well as concept exploration, remains a critical aspect of science.

Because the concepts found in the Common Curriculum Goals may not be uniformly understood in their new context, a set of papers has been designed and developed to help teachers incorporate the concepts into their curriculum. Each paper is designed to introduce the concept and help define it in teacher language using examples from the contemporary curriculum; suggest sample instructional objectives that are desirable for concept learning; and provide sample text questions with a commentary as to their appropriateness for measuring concept learning.

These teaching aids (TASC Papers) are intended to serve only as a starting point for understanding the concepts. They are not intended to be definitive statements about the concepts. As a district begins the process of incorporating the Common Curriculum Goals for Science into its program, the papers will serve as a common framework for discussions among staff. They have been field-tested in workshop settings with groups of K-12 teachers and it has been found that these inter-discipline, cross grade-level discussions result in expanded and enriched definitions and understanding of the concepts.

The full set of 25 concept papers are currently being developed in sets of five. The first set will be available in the summer of 1989. All five sets will be available by summer 1990.

In addition to these 25 TASC Papers, there are five Science Curriculum Concept Papers (SCCP) meant to explain the assumptions which underlie the Common Curriculum Goals. The titles of these papers are found in the "Sources of Information" section at the back of this document.

Science education should be for all students. The science goals outlined in this document are consistent with the nature of the subject and the nature of all learners. This consistency means that students are learning science in ways that allow them to explore relationships and develop understandings. The fundamental premise on which this document is based is that every aspect of school science encountered by students should enhance their understanding of science, enabling them to become environmentally, scientifically, and technologically literate citizens of the twenty-first century.

The Oregon Action Plan for Excellence established the direction for school improvement in this state with the ***Essential Learning Skills*** document outlining the common skills to be addressed across all program areas for elementary and secondary education. This document, ***Science Education: Comprehensive Curriculum Goals***, is written in relationship to that document as well as Oregon's Framework for Science Programs (1979) and the Science Common Knowledge and Skills.

DOCUMENT ORGANIZATION

In order to provide a curriculum consistent with the philosophy outlined above, the Comprehensive Curriculum Goals for Science have been organized into seven strands. They are as follows:

1.0 Concepts. Students apply an understanding of fundamental concepts on which science is based.

2.0 Processes. Students apply problem solving and inquiry processes.

3.0 Manipulative Skills. Students use a variety of materials and equipment in a safe and scientific way.

4.0 Interests. Students develop interest in science.

5.0 Values. Students apply the values that underlie science.

6.0 Interactions. Students describe interactions among science, society, technology and the earth's environment.

7.0 Characteristics. Students describe the characteristics of scientific knowledge.

The student objectives in each content strand include both the Essential Learning Skills deemed appropriate for science instruction and the Common Knowledge and Skills unique to science. The Essential Learning Skills are referenced by citing their original identification numbers (e.g., ELS 6.4). Underlining marks the addition of the Common Knowledge and Skills of science and certain Essential Learning Skills when the intent is retained but the wording has been significantly altered.

It is very important to remember that the student outcomes appearing in the columns headed Grade 3, Grade 5, Grade 8 and Grade 11 are expectancies for students to reach by the end of these grade levels. An expectancy appearing in the Grade 3 column, for example, represents a goal to be achieved as a result of four years of learning.

COMPREHENSIVE CURRICULUM GOALS

In order to provide a K-12 science curriculum consistent with the philosophy stated in the philosophy/rationale section of this document, the Comprehensive Goals for Science have been organized into seven strands.

Concepts

Students apply an understanding of fundamental concepts on which science is based. The concepts are organized for categories of events or objects.

There are at least two ways to identify and think about science concepts. One is idiosyncratically, i.e., the unifying concepts within each particular discipline or subject which undergird it. Another, is to identify concepts (e.g., cause and effect, change, cycle, energy-matter, organism, and population) which represents a minimal conceptual core of science knowledge. Each key concept can be viewed as a continuum along which the individual progresses as she/he learns more complex relationships (e.g., principles, laws) involving the concept.

1.0 Concepts. Students apply an understanding of fundamental concepts on which science is based.

1.1 DEMONSTRATE CAUSE AND EFFECT: RELATED SERIES OF TWO OR MORE EVENTS THAT LEAD ONE TO BELIEVE THAT NATURE IS PREDICTABLE (E.G., ACID RAIN AFFECTING PLANT GROWTH, CHANGING THE TEMPERATURE OF A MATERIAL, CHEMICAL REACTIONS)*

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
		[a] Explore possible causes for an observable event	[a] State possible causes for an observable event	[a] State possible causes for an observable event
			[b] Identify the relationship between a cause and an effect	[b] Identify the relationship between a cause and an effect
			[c] Construct a diagram that depicts cause and effect	[c] Explain a diagram that shows cause and effect

1.2 DEMONSTRATE CHANGE: THE PROCESS OF THINGS BECOMING DIFFERENT OVER TIME (E.G., AGING, GROWTH, METAMORPHOSIS, FIRE, MOUNTAINS BREAKING UP) (ELS 6.1)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
[a] Identify examples of change in their environment	[a] Use their observations and experiences to define change	[a] Use their observations and experiences to define change	[a] Demonstrate a physical change with simple objects	[a] Describe changes in an environment
				[b] Predict the results of an experiment involving change

*Learning outcomes drawn from the *ODE Essential Learning Skills* document are cross-referenced to that document by citing their original identifying number in parentheses.
**All underlined skills and outcomes throughout this document indicate the required expectations from the *Science Common Curriculum Goals* in grades 3, 5, 8 and 11 and include the Essential Learning Skills.

1.1

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a State a hypothesis using a cause and effect relationship	a State a hypothesis using a cause and effect relationship	a State a hypothesis using a cause and effect relationship	a State a hypothesis using a cause and effect relationship
b Identify the relationship between a cause and an effect	b Identify a factor involved in a cause and effect relationship	b Identify the factors involved in a cause and effect relationship	b Demonstrate an understanding of factors involved in a cause and effect relationship by predicting the outcome of interacting events
			c Identify relationships and regularities from which a general statement can be made about the effects of change (e.g., temperature increase increases reaction rate)

1.2

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Give examples of different rates of change	a Demonstrate physical changes	a Demonstrate chemical changes	a Demonstrate physical and chemical changes
b Explain how things continue to have some of the same characteristics even though a major change occurs (ELS 6.1)	b Explain how things are different when a major change occurs	b Explain how things or ideas can change when interacting with others (ELS 6.1)	b Explain how things or ideas can change when interacting with others (ELS 6.1)

1.1

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a State a hypothesis using a cause and effect relationship relative to specific content area	a State a hypothesis using a cause and effect relationship relative to specific content area	a State a hypothesis using a cause and effect relationship relative to specific content area	a State a hypothesis using a cause and effect relationship relative to specific content area
b Demonstrate an understanding of factors involved in a cause and effect relationship by predicting the outcome of interacting events	b Demonstrate an understanding of factors involved in a cause and effect relationship by predicting the outcome of interacting events	b Demonstrate an understanding of factors involved in a cause and effect relationship by predicting the outcome of interacting events	b Evaluate predictions based on cause and effect relationship
c Identify relationships and regularities from which a general statement can be made about the effects of change (e.g., temperature increase increases reaction rate)	c Identify relationships and regularities from which a general statement can be made about the effects of change (e.g., temperature increase increases reaction rate)	c Identify relationships and regularities from which a general statement can be made about the effects of change (e.g., temperature increase increases reaction rate)	c Identify relationships and regularities from which a general statement can be made about the effects of change (e.g., temperature increase increases reaction rate)
d Discriminate between correlating patterns and true cause and effect	d Discriminate between correlating patterns and true cause and effect		

1.2

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Describe changes in the student's immediate environment	a Describe changes in the global environment	a Relate various examples of change in an environment (e.g., biophysical, geophysical)	a Predict possible changes in the environment
b Explain how things or ideas can change when interacting with others (ELS 6.1)	b Make conclusions based on own previous observations or experiences, about interactions of two or more things or ideas (ELS 6.1)	b Defend conclusions, based on own previous observations or experiences, about interactions of two or more things or ideas (ELS 6.1)	b Evaluate a person's defense of their conclusions

1.2 DEMONSTRATE CHANGE: THE PROCESS OF THINGS BECOMING DIFFERENT OVER TIME (E.G., AGING, GROWTH, METAMORPHOSIS, FIRE, MOUNTAINS BREAKING UP) (ELS 6.1) (continued)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[c] Demonstrate different rates of change using simple objects (e.g., ice melting, water evaporating)

1.3 DEMONSTRATE CYCLE: A PATTERN IN WHICH EVENTS OR CONDITIONS REPEAT AT REGULAR OR IRREGULAR INTERVALS (E.G., DAY AND NIGHT, SEASONS, REPRODUCTIVE CYCLES, NITROGEN AND CARBON CYCLES)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
[a] Explore patterns	[a] Explore patterns	[a] Recognize a cycle	[a] Recognize a cycle	[a] Demonstrate a cycle
		[b] Arrange parts of a cycle	[b] Arrange parts of a cycle	[b] Arrange parts of a cycle
		[c] Relate cycle to predictability	[c] Relate cycle to predictability	[c] Identify the pattern of a cycle

1.2

GRADE 5	GRADE 6	GRADE 7	GRADE 8
	c Demonstrate examples of different rates of change	c Identify linear and nonlinear rates of change	c Describe linear and nonlinear rates of change
			d Distinguish between physical and chemical changes

1.3

GRADE 5	GRADE 6	GRADE 7	GRADE 8
	a Use cycles to explain relationships in the environment	a Use cycles to explain relationships in the environment	a Use cycles to explain relationships in the environment
b Arrange parts of cycles	b Diagram a cycle	b Diagram a cycle	b Diagram a cycle
c Identify oscillation in a cycle	c Identify oscillation in a cycle	c Identify examples of recurrence and predictability	c Investigate ideas of recurrence and predictability

1.2

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[c] Use graphing to show rates of change	[c] Compute rates of change		

1.3

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Describe various examples of cycles in the environment or within organisms	[a] Describe various examples of cycles in the environment or within organisms	[a] Describe various examples of cycles in the environment or within organisms	[a] Describe various examples of cycles in the environment or within organisms
[b] Relate parts of one cycle with parts of another (e.g., tides and moon)	[b] Relate parts of one cycle with parts of another (e.g., tides and moon)		
[c] Distinguish between cycles which oscillate and those which have irregular intervals	[c] From a given cycle predict changes that would occur if the cycle is disrupted	[c] Identify how a disruption of a cycle changes other aspects of the environment	[c] Evaluate the impact of a change due to disruption of a cycle

1.4 DEMONSTRATE ENERGY-MATTER: MUTUALLY CONVERTIBLE EQUIVALENTS ("STUFF") FROM WHICH THE UNIVERSE IS MADE. MATTER CONTAINS ENERGY IN MANY FORMS (E.G., STATES OF MATTER ARE DETERMINED BY ENERGY IN MOTION, NUCLEAR ENERGY COMES FROM THE NUCLEUS WHEN ATOMS SPLIT OR FUSE)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
		[a] Explore solids, liquids and gases	[a] Identify states of matter and energy (e.g., solid, liquid, gas)	[a] Describe the relationship of energy to matter when matter changes state (e.g., heat can cause melting or evaporation, cooling can cause condensation or freezing) [b] Recognize energy can change form (e.g., electricity can convert to light)

1.5 DEMONSTRATE ORGANISM: A SYSTEM LIVING OR ONCE LIVING CHARACTERIZED BY THE PROCESSES OF LIFE (E.G., PLANTS AND ANIMALS: UNICELLULAR/ BACTERIA)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
	[a] Identify characteristics of organisms that distinguish them from nonliving systems	[a] Identify characteristics of organisms that distinguish them from nonliving systems	[a] List characteristics of organisms that distinguish them from nonliving systems	[a] Identify the major life processes (e.g., digestion, locomotion, respiration, reproduction) that occur in an organism
[b] Explore the basic needs of plants and animals	[b] Identify the basic needs of plants and animals	[b] Identify the basic needs of plants and animals	[b] Identify the basic needs of plants and animals	

1.4

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Recognize the release of energy from matter (e.g., burning)	a Demonstrate that energy is required to change states of matter	a Demonstrate that energy can be produced when changing states of matter	a Describe and demonstrate how technology utilizes the scientific tenets of the relationship between energy and matter (e.g., nuclear medicine, nuclear energy for producing electricity, electric motor)
b Recognize the converting of one energy form to another (e.g., mechanical rotation for transforming electricity)	b Define energy and matter	b Define energy and matter	b Define energy and matter
		c Identify sources of energy in the environment	c Recognize that the interaction of energy and matter determine the nature of the environment
	d Define renewable and non-renewable resources	d Identify renewable and non-renewable resources	d Describe the difference between renewable and nonrenewable resources

1.5

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Identify the major life processes (e.g., digestion, locomotion, respiration, reproduction) that occur in an organism	a Observe major life processes	a Observe the interaction of life processes	a Demonstrate an understanding of the effect that one of the life processes (e.g., ingestion of food) has on another process (e.g., growth as a result of ingesting food)

35

36

1.4

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Describe and demonstrate how technology utilizes the scientific tenets of the relationship between energy and matter (e.g., nuclear medicine, active solar storage units, electric motor)	a Describe and demonstrate how technology utilizes the scientific tenets of the relationship between energy and matter (e.g., nuclear medicine, active solar storage units, electric motor)	a Describe and demonstrate how technology utilizes the scientific tenets of the relationship between energy and matter (e.g., nuclear medicine, active solar storage units, electric motor)	a Evaluate how technology utilizes the scientific tenets of the relationship between energy and matter
b Classify energy sources into basic types (e.g., potential, kinetic, elastic potentials)	b Identify types of energy found in an energy source (e.g., petroleum and chemical potential, rubberband and elastic potential)	b Describe the relationship between energy sources and conversions	b Use standard units of energy to measure conversions
d Identify sources of energy as renewable and nonrenewable	d Identify societal issues involved with nonrenewable sources	d Suggest solutions to problems associated with nonrenewable resources	d Evaluate solutions to problems associated with nonrenewable resources

1.5

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Identify characteristics of organisms that distinguish them from nonliving systems	a Measure the effect that one life process has on another (e.g., respiration on locomotion)	a Measure the effect that one life process has on another (e.g., respiration on locomotion)	a Evaluate the effects of humans on the life processes in other living organisms

1.6 DEMONSTRATE POPULATION: A GROUP OF STRUCTURAL OR FUNCTIONAL UNITS THAT HAVE SPECIFIC OR COMMON CHARACTERISTICS (E.G., ORGANISMS)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
		[a] Identify objects with similar characteristics	[a] Identify characteristics which define and limit a given population (e.g., set of objects with exclusive characteristics)	[a] Identify and describe a population
		[b] Observe or describe characteristics of a population of animals		

1.7 DEMONSTRATE EQUILIBRIUM: A STATE OF BALANCE OF EQUALITY BETWEEN OPPOSING FORCES (E.G., SEESAW, DIFFUSION OF MOLECULES FROM HIGH TO LOW CONCENTRATION) AFTER RATES REACH A BALANCED STATE

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Define and demonstrate balance (e.g., seesaw)

1.6

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Identify and describe a population	a Describe how interaction and change affect individuals in populations and the populations themselves	a Describe how interaction and change affect individuals in populations and the populations themselves	a Describe how interaction and change affect individuals in populations and the populations themselves

1.7

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Define and demonstrate balance	a Identify static and dynamic forms of equilibrium	a Define static and dynamic forms of equilibrium	a Distinguish between static and dynamic forms of equilibrium
		b Observe a state of equilibrium	b Demonstrate a state of equilibrium (e.g., a boat floating, hot air balloon in flight)

1.6

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Use basic population dynamics to explain and predict future population changes	a Use basic population dynamics to explain and predict future population changes	a Use basic population dynamics to explain and predict current and future problems	a Evaluate solutions to population problems
b Measure attributes of a population (e.g., density, mass)	Use mathematical techniques to graph population changes (e.g., rates, numbers)	b Describe environmental effects and population interaction effects that result in predictable population changes	

1.7

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Give examples of static and dynamic equilibrium	a Give examples of static and dynamic equilibrium		
b Demonstrate an understanding of equilibrium in various settings (e.g., physical, biological, geological)	b Demonstrate an understanding of equilibrium in various settings (e.g., physical, biological, geological)	b Demonstrate an understanding of equilibrium in various settings (e.g., physical, biological, geological)	

1.8 DEMONSTRATE EVOLUTION: A SERIES OF CHANGES THAT CAN BE USED TO EXPLAIN HOW SOMETHING HAS BECOME THE WAY IT IS OR TO PREDICT WHAT IT MIGHT BECOME (E.G., SIMPLE ANIMAL AND PLANT FORMS TO MORE COMPLEX FORMS)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

1.9 DEMONSTRATE FORCE: A PUSH OR PULL AGAINST RESISTANCE WHICH CAUSES ACTION, INACTION OR CHANGE (E.G., CATAPULT, GRAVITY, CHANGE THE SPEED OR DIRECTION OF MOTION, STOP MOTION)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
		[a] Explore forces on a moving object	[a] Identify and change forces on moving objects	[a] Identify and change forces on an object [b] Identify force as a push or pull

1.10 DEMONSTRATE FUNDAMENTAL ENTITIES: UNITS OF STRUCTURE AND FUNCTION USEFUL IN EXPLAINING PHENOMENA (E.G., ORGANISM IN POPULATIONS, METHODS OF MEASUREMENTS)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Recognize basic units that make up objects or systems

1.8

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Recognize that evolution is the process of change over time	a Identify situations where change over time has occurred	a Describe an example of change over time	a Illustrate and experiment with different ways that things/objects (e.g., organisms, technology, automobile styles, geological features) change over time
b Identify adaptations of plant and animal parts		b Identify natural process changes	b Identify natural process changes

1.9

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Identify and change forces on an object	a Observe forces in the environment	a Predict and explain the outcome of situations where forces interact (e.g., isometric exercises, isotonic solutions)	a Predict and explain the outcome of situations where forces interact (e.g., isometric exercises, isotonic solutions)
b Identify force as a push or pull	b Demonstrate forces in the environment		

1.10

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Recognize basic units that make up objects and systems	a Recognize basic units that make up objects and systems	a Recognize basic units that make up objects and systems	a Recognize basic units that make up objects and systems

1.8

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Identify, predict and experiment with the factors that relate to evolutionary change in a situation (e.g., organism, environment)	[a] Identify, predict and experiment with the factors that relate to evolutionary change in a situation (e.g., organism, environment)	[a] Identify, predict and experiment with the factors that relate to evolutionary change in a situation (e.g., organism, environment)	
[b] Identify changes in a system that show adaptation to new conditions (e.g., lungs and land, clothing and changes in morality)	[b] Identify human directed changes and their effects	[b] Distinguish between human-directed changes and natural processes (e.g., designed automobile styles vs. natural selection in living organisms)	

1.9

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Predict and explain the outcome of situations where forces interact (e.g., isometric exercises, isotonic solutions)	[a] Predict and explain the outcome of situations where forces interact (e.g., isometric exercises, isotonic solutions)	[a] Develop and explain a model which demonstrates the concept of force (e.g., lift on an airfoil, rocket's effect on direction of flight in outer space)	[a] Compute forces in various situations

1.10

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Use basic units which make up objects and more complex systems	[a] Use basic units which make up objects and more complex systems	[a] Recognize and use appropriate fundamental units to explain structure and function of an object or system in an event	

1.11 DEMONSTRATE INTERACTION: TWO OR MORE THINGS INFLUENCING EACH OTHER (E.G., POPULATION/FOOD, HOT/COLD, ACID/BASE, FORCE/MOVEMENT, VOLUME/PRESSURE)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Recognize interactions by noting the object or condition that causes a change

1.12 DEMONSTRATE ORDER: THE TENET THAT THERE IS ORDER IN NATURE OR THAT ORDER CAN BE DESCRIBED IN THE VARIOUS SCHEMES OR PATTERNS OF NATURE (E.G., PERIODIC TABLE, TIDES, SUNRISE/SUNSET)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Recognize examples of systems used to order objects and events (e.g., food chains)

1.13 DEMONSTRATE QUANTIFICATION: A NUMBER AND UNIT RESULTING FROM A MEASUREMENT OF SOME REAL OR ABSTRACT THING, SITUATION OR EVENT (E.G., DISTANCE, TIME, MASS, METRIC SYSTEM (METER/SECOND/GRAM), DENSITY, SOLUBILITY, PROBABILITY)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Collect and record data using appropriate units of measurement

1.11

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Recognize interactions by noting the object or condition that causes a change	a Recognize interactions by noting the object or condition that was changed	a Identify a variety of interactions	a Use interactions to predict an outcome
		b Identify several variables in a system than could influence an outcome	b Change variables and explore the resulting interactions

1.12

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Give examples of systems used to order objects or events (e.g., food chains)	a Order a given group of objects	a Order a given group of common events by using criteria	a Order a given group of objects or common events by using one or more criterion

1.13

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Collect and record data using appropriate units of measurement	a Organize quantitative data	a Organize and graph data	a Create a pictorial or graphic representation of data

1.11

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Given an outcome, identify the interactions required to produce this result	[a] Determine if there may be more than one interaction in a complex system	[a] Identify levels of interactions within a complex system	[a] Evaluate relative importance of various interactions in determining the net outcome of a complex system
[b] Describe the relationship between variables in a system	[b] Describe the relationship between variables in a system	[b] Describe the relationship between variables in a system	[b] Quantitatively describe the relationship between variables in a system

1.12

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Order a given group of objects or common events by using one or more criterion	[a] Organize a group of objects or events of the student's choice, using one or more criterion	[a] Construct and use a dichotomous key which illustrates order	[a] Evaluate someone else's key as to relevance, logic, and ease of use

1.13

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Graph the same data using more than one graphing method	[a] Analyze graphed data to draw conclusions and make predictions	[a] Analyze data to draw conclusions and make predictions	[a] Evaluate someone else's conclusions or predictions made from a graph
	[b] Given several data table formats, select the one most appropriate for a particular set of data	[b] Create appropriate data tables to collect and organize data	[b] Use graphical or mathematical interpolation or extrapolation to fill in missing numbers on a data table
[c] Understand, in a qualitative manner, that all measurements contain error	[c] Understand, in a qualitative manner, that all measurements contain error	[c] Demonstrate an understanding of measurement error (e.g., ±0.5)	[c] Use the concept of significant figures in calculations involving real world data
	[d] Determine the importance of measurement in an investigation	[d] Determine the importance of measurement in an investigation	

1.14 DEMONSTRATE SYSTEM: A SET OF PARTS THAT FUNCTION TOGETHER AS A WHOLE. THE PARTS CAN BE DISCUSSED OR STUDIED INDIVIDUALLY FOR MORE EFFECTIVE LEARNING (E.G., PARTS OF A FLOWER, DIGESTIVE SYSTEM OF THE BODY, ELECTRIC MOTORS)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Recognize parts of a system

1.15 DEMONSTRATE THEORY: A PLAUSIBLE OR SCIENTIFICALLY ACCEPTABLE EXPLANATION MADE UP OF MODELS, CONCEPTS, AND PRINCIPLES OF SOME OBSERVED THING, PHENOMENON OR THOUGHT (E.G., DEVELOPMENT OF EARTH, ATOM, UNIVERSE)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Identify a theory

1.16 DEMONSTRATE FIELD: A REGION AROUND SOMETHING THAT INFLUENCES SOME OTHER THING OFTEN WITHOUT TOUCHING (E.G., MAGNETIC, ELECTRICAL, GRAVITATIONAL)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

1.14

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Recognize and diagram the parts of a system	a Identify functions of the parts of a system	a Observe interactions between/ among parts of a system	a Identify interactions between/ among parts of a system
		b Define input and output in a system	b Identify input and output in a system
		c Examine the interrelationships of the components of common systems	c Diagram and explain the interrelationships of the components of common systems

1.15

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Define a theory	a Give examples of theories	a Identify a theory that has changed	a Recognize that theories are tentative
			b Recognize examples of theories

1.16

GRADE 5	GRADE 6	GRADE 7	GRADE 8
		a Observe force fields	a Identify and describe a force field (e.g., magnetic field)

1.14

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Identify interactions between/among parts of a system	[a] Examine systems to determine the effects of interaction between/among the parts	[a] Examine systems to determine the effects of interactions between/among the parts	[a] Recognize a hierarchy of systems: systems, subsystems and supersystems
[b] Identify input and output in a system	[b] Identify input and output in a system		

1.15

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Describe how a theory is changed by scientific evidence	[a] Use a theory to explain relationships between several objects or events	[a] Use a theory to explain relationships between several objects or events	
[b] Recognize examples of theories	[b] Identify strengths and weaknesses of theories	[b] Evaluate strengths and weaknesses of various scientific theories	

1.16

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Identify the characteristics of a field	[a] Describe how objects interact with a field	[a] Develop and explain a model which demonstrates the concept of field	[a] Develop and explain a model which demonstrates the concept of field

1.17 DEMONSTRATE GRADIENT: A SITUATION IN WHICH THE INTENSITY OF SOMETHING INCREASES OR DECREASES IN A MORE OR LESS REGULAR PATTERN (E.G., TEMPERATURE CHANGES AS DISTANCE FROM HEAT SOURCE IS VARIED, STREAM FLOW, LIGHT INTENSITY CHANGES AS DISTANCE FROM LIGHT SOURCE IS VARIED)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

1.18 DEMONSTRATE INVARIANCE: A CHARACTERISTIC OF AN OBJECT OR A SITUATION WHICH STAYS CONSTANT EVEN THOUGH OTHER CHARACTERISTICS MAY CHANGE (E.G., NUMBER OR PROTONS IN NUCLEUS, LIFE (TIME RELATED), TOTAL MASS IN CHEMICAL REACTION)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

1.19 DEMONSTRATE MODEL: PROPOSED IDEA OF THE COMPOSITION AND RELATIONSHIPS PRESENT IN SOMETHING THAT CANNOT BE OBSERVED DIRECTLY (E.G., BLACK BOX, BLACK HOLE)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

[a] Recognize what a model is and why it is used (e.g., structure of earth, light, sound, heat)

1.17

GRADE 5	GRADE 6	GRADE 7	GRADE 8
	[a] Define a gradient	[a] Identify the components of a gradient	a Describe the variations in a gradient
			[b] Observe and record results of an experiment that illustrates gradients

1.18

GRADE 5	GRADE 6	GRADE 7	GRADE 8
		[a] Examine examples of invariance	a Recognize and describe invariance in biological and physical systems

1.19

GRADE 5	GRADE 6	GRADE 7	GRADE 8
[a] Recognize what a model is and why it is used (e.g., solar system)	[a] Design a model to show a system	[a] Build a model to explain a system	a Use models to explain natural systems (e.g., plate tectonics)
			[b] Identify characteristics of all scientific models
			[c] Identify the characteristics of various model types (e.g. scale, replica)

1.17

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Measure gradients using standard or arbitrary units (e.g., light intensity, magnetic attraction)	[a] Describe a pattern of change within a gradient	[a] Use concept of gradient to predict from existing data	[a] Use concept of gradient to predict from existing data
		[b] Measure and graph the results of an experiment to illustrate gradient	

1.18

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Identify parts of a system that are invariant and those that change	[a] Identify the characteristics of a system that are a result of invariance (e.g., numbers of protons in element and properties of that element)	[a] Explain invariance in a system	

1.19

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Use models to explain natural systems (e.g., plate tectonics)	[a] As a group, evaluate possible models for one phenomenon	[a] Explain and evaluate a model	[a] Identify models used in our society
[b] Use a model to make a prediction	[b] Use a model to make a prediction	[b] Use a model to make a prediction	
[c] Identify characteristics of various model types (e.g., scaled down, scaled up, transparent, time distortion)	[c] Identify characteristics of various model types (e.g., scaled down, scaled up, transparent, time distortion)	[c] Develop a model to explain the function or structure of a phenomenon	

1.20 DEMONSTRATE PERCEPTION: THE MIND'S INTERPRETATION OF SENSORY INPUT (E.G., ILLUSIONS, USE OF SENSORY LIMITATIONS TO EXTEND PERCEPTION OF SCIENTIFIC EQUIPMENT)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

1.21 DEMONSTRATE PROBABILITY: AN EXPRESSION OF THE LIKELIHOOD THAT A SITUATION OR EVENT WILL OCCUR (E.G., FLIPPING COINS FOR HEADS OR TAILS, CARDS, NUMBERS, GENETICS, TYPES OF ORGANISMS, EARTHQUAKES, ELECTRON ORBITS)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

1.22 DEMONSTRATE REPLICATION: REPEATING THE SAME CONDITION IN EXPECTATION THAT THE SAME RESULTS WILL BE PRODUCED (E.G., SAME SOIL CONDITION PRODUCES SAME SIZE PLANT, SAME INGREDIENTS IN SAME PRODUCT)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

[a] Repeat a simple experiment

1.20

GRADE 5	GRADE 6	GRADE 7	GRADE 8
	a Define perception	a Use optical illusions to examine perception	a Describe things that change perception
		b Identify differences in people that may influence perception	b Explain how perception may differ from person to person

1.21

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Explain how a number of data points (e.g., time vs. temperature) influence probability	a Recognize that number of data points may help to identify a pattern	a Recognize that number of data points may help to identify a pattern	a Use data to recognize differences in predicted and actual outcomes
			b Explain the differences between high probability and certainty

1.22

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Repeat a simple experiment	a Repeat a simple experiment	a Describe the importance of replication in experiments	a Describe the importance of replication in experiments

71

72

1.20

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Describe things that change perception (e.g., light levels, noise, drugs)	a Describe and demonstrate how an instrument can be used to modify perception (e.g., microscope)	a Describe and demonstrate how an instrument can be used to modify perception (e.g., microscope)	a Identify the perception distortions of an instrument
b Describe past experiences that can alter perceptions	b Describe past experiences that can alter perceptions	b Describe past experiences that can alter perceptions	

1.21

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Use data to recognize differences in predicted and actual outcomes	a Apply basic principles of probability to predict outcome of events	a Apply basic principles of probability to predict outcome of events	a Evaluate the validity of particular statistical treatments in various situations
	b Identify the uses of probability and statistics in the real world setting	b Describe and illustrate statistical significance	b Predict the probabilities of various worldwide scenarios (e.g., ozone depletion, greenhouse effect, nuclear war, energy storage)

1.22

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Describe the importance of replication in experiments	a Design an experiment to replicate results	a Design an experiment to replicate results	
b Explain why different individuals, doing the same experiment may not get the same results	b Explain why different individuals, doing the same experiment may not get the same results	b Explain why different individuals, doing the same experiment may not get the same results	b Evaluate the validity of an experiment based on the degree to which data is replicated
		c Explain and use statistical means to evaluate accuracy and precision (e.g., standard deviation)	

1.23 DEMONSTRATE SCALE: THE UNDERSTANDING THAT CHARACTERISTICS MAY CHANGE AS A SYSTEM'S DIMENSIONS ARE INCREASED OR DECREASED (E.G., MAPS, GLOBES, MODELS OF CARS OR PLANETS, OR HOUSES)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[b] Design a map, drawing it to scale

1.24 DEMONSTRATE SYMMETRY: STRUCTURALLY BALANCED (E.G., SNOWFLAKES, AIRPLANE BODY, RIGHT AND LEFT SIDE OF HUMAN BODY, SPHERE)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[b] Identify examples of symmetry found in the environment

1.23

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Demonstrate proportion as an actual scaled size		a Identify limitations of a scale model	a Explain the limitations of scale models used to represent natural phenomena (e.g., atom, solar system)
b Design a map, drawing it to scale	b Draw the same map to several scales	b Build a model to scale	

1.24

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Demonstrate bilateral and radial symmetry	a Identify types of symmetry found in the environment	a Identify types of symmetry in living systems	a Relate types of symmetry to function in natural systems
b Identify examples of symmetry found in the environment			

1.23

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Identify areas where a smaller scale must be used to explain a larger system	a Identify areas where a smaller scale must be used to explain a larger system	a Explain the change of a variable's effect on a system as a result of a change in scale (e.g., linear to logrithmic) b Predict changes that will occur as a result of change in scale	

1.24

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Demonstrate how symmetry in given situations relates to design and function	a Demonstrate how symmetry in given situations relates to design and function b Discuss symmetry relative to growth patterns	a Demonstrate how symmetry in given situations relates to design and function b Discuss symmetry relative to growth patterns	a Speculate the changes in a system if the symmetry were different

1.25 DEMONSTRATE TIME-SPACE: THE TIMING OF AN EVENT MOVING FROM POINT A TO POINT B (E.G., MPH OR KM/H, AUTOMOBILES SEPARATED BY SPACE OF 3 SECONDS, VELOCITY OR VECTOR, SPEED OF NERVE IMPULSE)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Observe the difference in time as objects move through space (e.g., running vs. walking down a hall, observation of lightening vs. hearing thunder during a storm)

1.25

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Demonstrate comprehension of the concept of movement	a Measure and record the time for an event to occur	a Use a scale to measure the time and space relationship of an event	a Recognize and explain scales in measuring time and space
			b Demonstrate ability to use time and space to describe events (e.g., speed, relative position)
		c Graph time-space relationships	c Graph time-space relationships

GRADE 9	GRADE 10	GRADE 11	GRADE 12
	[a] Develop and use a system to measure time and space	[a] Demonstrate ability to accurately time events during investigations	
	[b] Calculate rate of change	[b] Demonstrate rate of change (e.g., speed, reaction rate, growth)	[b] Using experimental data, predict rates of change
[c] Graph time-space relationships	[c] Graph time-space relationships	[c] Graph time-space relationships	
			[d] Describe modern theories of time-space relationships

Processes

Students apply problem-solving and inquiry skills. The process skills of science are not independent of content. They are not merely "activity" in the name of "hands-on" science. The process skills are divided into basic processes (e.g., observe, measure, use numbers, classify, question, communicate) and integrated processes (e.g., design experiments, control variables, interpret data) providing foundations for more complex processes. The process skills are, in fact, interdependent with content and are used relationally, i.e., with objects or events.

2.0 Processes. Students apply problem-solving and inquiry processes.

2.1 OBSERVE: MAKE ACCURATE OBSERVATIONS OF OBJECTS AND EVENTS USING THE SENSES OR INSTRUMENTS TO AID THE SENSES* (ELS 4.1)**

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
a Explore objects using all senses	a Describe physical properties of objects observed by using the senses	a Describe physical properties of objects observed by using the senses	a Describe physical properties of objects observed by using the senses	a Describe and compare the physical properties of objects (e.g., rocks, plants, animals)
	b Use simple instruments (e.g., hand lens, stethoscope) to enhance qualitative observations	b Use simple instruments (e.g., hand lens, stethoscope) to enhance qualitative observations	b Use simple instruments (e.g., hand lens, stethoscope) to enhance qualitative observations	b Use instruments (e.g., thermometer, computer, balance) to enhance quantitative observations
	c Operationally define the process of observation (i.e., label the process from experiences)	c Operationally define the process of observation (i.e., label the process from experiences)	c Operationally define the process of observation (i.e., label the process from experiences)	

2.2 MEASURE: USE MEASURING DEVICES TO COLLECT DATA (ELS 1.7)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
	a Explore measurement using arbitrary (e.g., weight using paperclips, crayon lengths) and standard measuring devices	a Explore measurement using arbitrary and standard measuring devices	a Compare objects to an arbitrary measuring device (e.g., comparing sticks of a varying length to one of a given length)	a Use the appropriate instrument for measurement in metric and English (U.S. Customary) units
			b Identify measurable properties (e.g., length, weight, mass, volume) of a given object	b Measure and record the properties (e.g., length, weight, time) of an object or event
			c Measure using a variety of arbitrary and standard measuring devices	

2.1

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Describe changes observed in an object or event (e.g., metamorphosis of a Monarch butterfly, freezing water in a closed container)	a Observe and record a sequence of changes in an object or event	a Distinguish the properties of objects by subjecting them to tests	a Distinguish the properties of objects directly or by manipulating or changing objects to observe their properties
b Use instruments (e.g., thermometer, camera, videotape, balance, computer) to enhance qualitative and quantitative observations of change within an object or an event	b Use instruments (e.g., thermometer, camera, videotape, balance, computer) to enhance qualitative and quantitative observations of change within an object or an event	b Use appropriate instruments to repeat and verify qualitative and quantitative observations in order to establish consistency	b Use appropriate instruments to repeat and verify qualitative and quantitative observations in order to establish consistency

2.2

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Select and use the appropriate instrument for measurement in metric and English (U.S. Customary) units (ELS 1.7)	a Select and use the appropriate instrument for measurement in metric and English (U.S. Customary) units (ELS 1.7)	a Select and use the appropriate instrument for measurement in metric and English (U.S. Customary) units (ELS 1.7)	a Select and use the appropriate instrument for measurement in metric and English (U.S. Customary) units (ELS 1.7)
b Measure and record the properties (e.g., length, weight, mass, volume, temperature, time) of an object or event	b Measure and record the properties (e.g., length, weight, mass, volume, temperature, time) of an object or event	b Measure and record the properties (e.g., length, weight, mass, volume, temperature, time) of an object or event	b Measure and record the properties (e.g., length, weight, mass, volume, temperature, time) of an object or event

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2.1

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Select and use quantitative and qualitative observations in appropriate ways as opposed to ambiguous and influential information	a Describe why certain observations are preferred over others (e.g., quantitative, qualitative, senses, instruments)	a Separate pertinent observations from extraneous observations in an investigation	a Using pertinent observations make hypotheses
b Select the appropriate instruments for data gathering	b Determine alternate instruments for data gathering	b Use appropriate instruments to refine quantitative and qualitative observations	b Evaluate the use of appropriate instruments

2.2

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Use appropriate metric instruments (e.g., metric ruler, clock, balance, graduated cylinder) to gather data	a Use appropriate metric instruments to measure quantities that depend on one variable (e.g., length, mass, time)	a Evaluate (calculate) quantities that depend on more than one variable (e.g., density, pressure, velocity, momentum)	a Given a problem, predict the types of instruments and measurements needed to record proper data
b Measure and record data in an organized way (e.g., tables, charts, graphs, pictures)	b Identify limitations placed on an investigation by the measuring devices, senses and techniques used	b Identify limitations placed on an investigation by the measuring devices, senses and techniques used	b Evaluate a set of measurements (e.g., percent of error, standard deviation)
	c Recognize the use of special scales in science which may be used in everyday life (e.g., Richter, pH, clinical thermometer)	c Recognize the use of special scales in science which may be used in everyday life (e.g., Richter, pH, clinical thermometer)	

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2.3 USE NUMBERS: USE NUMBER/NUMERIC FIGURES, LETTERS, WORDS, SYMBOLS AND VISUALS TO COUNT, COMPUTE AND COMMUNICATE QUANTITATIVE DATA (ELS 1.4)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
		[a] Count and report totals of objects or events encountered in a science activity	[a] Use mental, manual or calculator processes to perform grade-level arithemetic operations in reporting scientific information and conducting scientific investigations (ELS 1.4)	[a] Use mental, manual or calculator processes to perform grade-level arithemetic operations in reporting scientific information and conducting scientific investigations (ELS 1.4)
			[b] Use simple histograms to report results of a scientific investigation	[b] Using graphs, record scientific data

2.4 RELATE TIME-SPACE: DESCRIBE SPATIAL RELATIONSHIPS AND THEIR CHANGE WITH TIME (ELS 1.6)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

2.3

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Use mental, manual or calculator processes to perform grade-level arithmetic operations in reporting scientific information and conducting scientific investigations (ELS 1.4)	a Use mental, manual or calculator processes to perform grade-level arithmetic operations in reporting scientific information and conducting scientific investigations (ELS 1.4)	a Use mental, manual, calculator and computer processes to perform grade-level mathematical operations in reporting scientific information and conducting scientific investigations (ELS 1.4)	a Use mental, manual, calculator and computer processes to perform grade-level mathematical operations in reporting scientific information and conducting scientific investigations (ELS 1.4)
b Interpret and construct tables and charts of scientific data (ELS 1.6)	b Interpret and construct tables and charts of scientific data (ELS 1.6)	b Interpret and construct graphs, charts and tables of scientific data (ELS 1.6)	b Interpret and construct graphs, charts and tables of scientific data (ELS 1.6)

2.4

GRADE 5	GRADE 6	GRADE 7	GRADE 8
		a Describe locations of an object	a Describe the location of an object relative to another object (e.g., reading and giving map directions)

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2.3

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Use mental, manual, calculator and computer processes to perform grade-level mathematical operations in reporting scientific information and conducting scientific investigations (ELS 1.4)	[a] Use mental, manual, calculator and computer processes to perform grade-level mathematical operations in reporting scientific information and conducting scientific investigations (ELS 1.4)	[a] Use mental, manual, calculator and computer processes to perform grade-level mathematical operations in reporting scientific information and conducting scientific investigations (ELS 1.4)	[a] Use mental, manual, calculator and computer processes to perform grade-level mathematical operations in reporting scientific information and conducting scientific investigations (ELS 1.4)
[b] Use tables, charts and graphs to communicate scientific data (ELS 1.6)	[b] Use tables, charts and graphs to communicate scientific data (ELS 1.6)	[b] Design tables, charts and graphs to show the relationship among variables (ELS 1.6)	[b] Design tables, charts and graphs to show the relationship among variables (ELS 1.6)

2.4

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Describe spatial relationships and their change with time (e.g., velocity, acceleration)	[a] Describe spatial relationships and their change with time (e.g., velocity, acceleration)	[a] Describe spatial relationships and their change with time (e.g., velocity, acceleration)	[a] Make predictions based on time-space data (e.g., greenhouse effect, AIDS)

2.5 INFER: RECOGNIZE, CONSTRUCT AND DRAW INFERENCES CONCERNING RELATIONSHIPS AMONG THINGS AND IDEAS (ELS 6.1)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

2.6 CLASSIFY: USE THE CHARACTERISTICS OF OBJECTS OR EVENTS TO GROUP THEM BY ORDERING SIMILARITIES (ELS 6.1)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
[a] Sort objects into sets	[a] Identify general characteristics of objects which make them similar or different from another (ELS 6.1) [b] Sequence (seriate) objects using one variable (e.g., smallest to largest, gradation of a color) (ELS 1.6) [c] Operationally define the process of classifying (i.e., label the process from experiences)	[a] Identify general characteristics of objects which make them similar or different from another (ELS 6.1) [b] Sequence (seriate) objects using one variable (e.g., smallest to largest, gradation of a color) (ELS 1.6)	[a] Identify general characteristics of objects which make them similar or different from another (ELS 6.1) [b] Sequence (seriate) objects using one variable (e.g., smallest to largest, gradation of a color) (ELS 1.6)	[a] Classify objects according to specific characteristics (ELS 6.1) [b] Sequence (seriate) objects using one variable (ELS 1.6)

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2.5

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Use a list of observations of an object or event (e.g., a spider building a web) to make an inference about the reason for or the function of the object or event	a Use a list of observations of an object or event (e.g., a spider building a web) to make an inference about the reason for or the function of the object or event	a Develop a list of observations of an object or event and make logical inferences based on the observations (ELS 6.4)	a Develop a list of observations of an object or event and make logical inferences based on the observations (ELS 6.4)
		b Discriminate between inference and direct observation	b Discriminate between inference and direct observation

2.6

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Classify objects according to specific characteristics (ELS 6.1)	a Identify patterns and multiple characteristics (ELS 6.1)	a Develop and use a classification system for organizing data (ELS 6.1)	a Using a given scheme, classify objects or ideas according to patterns/multiple characteristics (ELS 6.1)
b Sequence (seriate) objects using one variable (ELS 1.6)	b Sequence (seriate) objects using one variable (ELS 1.6)	b Identify and sequence (seriate) data by value (ELS 1.6)	b Identify and sequence (seriate) data by value (ELS 1.6)

2.5

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Identify observations which would support a given inference	[a] Identify observations which would support a given inference	[a] Develop alternative inferences from observations which could become hypotheses	[a] Develop alternative inferences from observations which could become hypotheses

2.6

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Describe examples of classification schemes used commonly in science	[a] Develop and use a classification system for organizing data	[a] Develop and use a classification system for organizing data	[a] Critique a classification system
[b] Identify and sequence (seriate) data by value (ELS 1.6)	[b] Identify and sequence (seriate) data by value (ELS 1.6)	[b] Identify and sequence (seriate) data by value (ELS 1.6)	

2.7 DEFINE OPERATIONALLY: USE THE COMMON CHARACTERISTICS OF SETS OF OBJECTS OR EVENTS OBSERVED OR EXPERIENCED TO DEVELOP DEFINITIONS OF THOSE OBJECTS OR EVENTS

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Develop a definition for a set from observations of members of the set (e.g., dogs)

2.8 QUESTION: IDENTIFY PROBLEMS AND DEVELOP TESTABLE QUESTIONS RELATING TO THE PROBLEMS (ELS 6.3)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
	[a] Identify problems that need a solution in a working investigation (e.g., which rubber band gives the best energy?)	[a] Identify problems that need a solution in a working investigation (e.g., why don't the wheels roll freely?)	[a] Identify problems that need a solution (ELS 6.3)	[a] List information needed to solve a problem
		[b] Recognize alternative solutions to a simple problem	[b] Identify alternative solutions to a simple problem (ELS 6.3)	[b] Identify alternative solutions to a simple problem (ELS 6.3)
[c] Ask questions about an object or event	[c] Ask questions about an object or event	[c] Ask questions about an object or event	[c] State questions relating to an object or event (ELS 2.3)	[c] After making observations about objects (e.g., dry and wet prunes) or events, list questions about those observations (e.g., why, how)

2.7

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Develop a definition for a set from observations of members of the set (e.g., dogs)	a Observe related events (e.g., attraction between magnets and objects) and develop a definition for the concept shown (e.g., field)	a Observe related events (e.g., attraction between magnets and objects) and develop a definition for the concept shown (e.g., field)	a Observe related events (e.g., attraction between magnets and objects) and develop a definition for the concept shown (e.g., field)

2.8

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Recognize information needed to solve a given problem	a Identify a problem and generate information necessary to understand the problem	a Identify a problem and generate information necessary to understand the problem	a Identify a problem and generate information necessary to understand the problem
b Develop questions designed to clarify a given problem (ELS 2.3)	b Develop questions designed to clarify a given problem (ELS 2.3)	b Develop testable questions designed to clarify the problem (ELS 2.3)	b Develop testable questions designed to clarify the problem (ELS 2.3)
c Use data from the questioning process to develop a problem-solving plan (ELS 6.3)	c After making observations about objects or events, list questions about these observations (e.g., why, how)		

2.7

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Observe related events (e.g., attraction between magnets and objects) and develop a definition for the concept shown (e.g., field)	[a] Observe related events (e.g., attraction between magnets and objects) and develop a definition for the concept shown (e.g., field)	[a] Use additional data to refine an operational definition	
[b] Display a preference for using operational definitions	[b] Identify reasons for different people having different operational definitions of the same concept		[b] Evaluate another persons operational definition of a concept

2.8

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Use a systematic method to identify a problem and propose a solution	[a] Give examples of real problems that may and may not have solutions	[a] Identify a problem which may have a solution; generate and evaluate information critical to the solution of the problem	[a] Identify a problem and propose a best solution based on a previously identified set of criteria
[b] Develop testable questions which may contribute to the solution of a problem (ELS 2.3)	[b] Develop testable questions which may contribute to the solution of a problem (ELS 2.3)	[b] Develop testable questions which may contribute to the solution of a problem (ELS 2.3)	[b] Use the testable question to help solve a problem of personal significance

2.9 HYPOTHESIZE: USE INFORMATION AND QUESTIONS TO GENERATE STATEMENTS THAT DESCRIBE EXPECTED RESULTS OF INVESTIGATION (ELS 6.2)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

2.10 DESIGN EXPERIMENTS: PLAN AND CONDUCT DATA GATHERING OPERATIONS TO TEST HYPOTHESES OR ANSWER QUESTIONS (ELS 6.3)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Follow directions to conduct an experiment
		[b] Solve problems using strategies such as guessing and checking, using concrete objects, making models, generating a pattern or drawing a picture (ELS 6.3)	[b] Solve problems using strategies such as guessing and checking, using concrete objects, making models, generating a pattern or drawing a picture (ELS 6.3)	[b] Solve problems using a variety of strategies such as guessing and checking, making predictions based upon a pattern, making a drawing or model (ELS 6.3)
[c] Engage in cooperative problem solving to arrive at a solution	[c] Engage in cooperative problem solving to arrive at a solution	[c] Engage in cooperative problem solving to arrive at a solution	[c] Engage in cooperative problem solving and compare alternative solution strategies (ELS 6.3)	[c] Engage in cooperative problem solving and compare alternative solution strategies (ELS 6.3)
			[d] Develop new suggestions or approaches if problem is not solved (ELS 6.3)	[d] Develop new suggestions or approaches if problem is not solved (ELS 6.3)

2.9

GRADE 5	GRADE 6	GRADE 7	GRADE 8
	a Use observation and questions to make an explanatory statement that can be tested	a Use observation and questions to make an explanatory statement that can be tested	a Use information and questions to generate statements that describe expected results of investigations

2.10

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Follow directions to conduct an experiment and identify the hypothesis used	a Follow directions to conduct an experiment and identify the hypothesis used	a Gather and organize data that may be used in testing a hypothesis	a Gather and organize data that may be used in testing a hypothesis
b Solve problems using a variety of strategies such as guessing and checking, making predictions based upon a pattern, making a drawing or model (ELS 6.3)	b Solve problems using a variety of strategies such as guessing and checking, making predictions based upon a pattern, making a drawing or model (ELS 6.3)	b Solve problems using appropriate strategies such as guessing and checking, making a systematic list, looking for patterns, making or drawing a model, eliminating possible answers or solving a simpler problem (ELS 6.3)	b Solve problems using appropriate strategies such as guessing and checking, making a systematic list, looking for patterns, making or drawing a model, eliminating possible answers or solving a simpler problem (ELS 6.3)
c Engage in cooperative problem-solving and compare alternative solution strategies (ELS 6.3)	c Engage in cooperative problem-solving and compare alternative solution strategies (ELS 6.3)	c Engage in cooperative problem-solving and compare alternative solution strategies (ELS 6.3)	c Engage in cooperative problem-solving and compare alternative solution strategies (ELS 6.3)
d Use formative (in process) data to modify or confirm problem-solving plan (ELS 6.3)	d Use formative (in process) data to modify or confirm problem-solving plan (ELS 6.3)	d Use summative (final) data to determine if the problem-solving approach was successful, and if not, how it should be modified (ELS 6.3)	d Use summative (final) data to determine if the problem-solving approach was successful, and if not, how it should be modified (ELS 6.3)

2.9

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Use information and questions to generate testable hypotheses	a Use information and questions to generate testable hypotheses	a Use information and questions to generate testable hypotheses	a Develop a hypothesis based on alternative inferences
		b Differentiate hypotheses that can be tested quantitatively from those that are limited to qualitative tests	b Suggest method by which qualitative testing of hypotheses can be quantified

2.10

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Identify information necessary to be included in a procedure	a Critique procedures written by others	a Design a procedure to test a hypothesis	a Collect data using a procedure that has been personally developed
b Identify advantages and disadvantages of various problem-solving techniques	b Recognize problem-solving techniques used by others	b Select and apply the most appropriate tools, methodologies, processes and operations in solving a variety of problems (ELS 6.3)	b Use problem-solving techniques in a science and society type problem
c Engage in cooperative problem solving and compare alternative solution strategies (ELS 6.3)	c Engage in cooperative problem solving and compare alternative solution strategies (ELS 6.3)	c Engage in cooperative problem solving and compare alternative solution strategies (ELS 6.3)	c Display a preference in cooperative problem solving where appropriate
d Use formative and summative data to determine if the problem-solving approach was successful and if not, how it should be modified	d Use formative and summative data to determine if the problem-solving approach was successful and if not, how it should be modified	d Analyze the formative and summative data to confirm or revise the proposed solution (ELS 6.3)	d Analyze the formative and summative data to confirm or revise the proposed solution

2.11 CONTROL VARIABLES: IDENTIFY AND MANAGE FACTORS THAT MAY INFLUENCE AN EXPERIMENT (ELS 3.1)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Identify factors that may influence the outcome of an investigation

2.12 INTERPRET DATA: FIND PATTERNS OR MEANINGS IN EXPERIMENTAL RESULTS (ELS 3.1, 6.2 and 6.4)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
		[a] State similarities in observations of several identical demonstrations or investigations (ELS 6.2)	[a] State similarities in observations of several identical demonstrations or investigations (ELS 6.2)	[a] Inspect data tables or charts to find changes in a variable

2.11

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Identify factors that may influence the outcome of an investigation	a Identify factors that may influence the outcome of an investigation	a Identify the controlled variables in an experiment	a Distinguish between controlled variables and variables which are being tested in an experiment
b Draw logical conclusions from information presented (ELS 3.1)	b Draw logical conclusions from information presented (ELS 3.1)	b Draw logical conclusions from information presented (ELS 3.1)	b Draw logical conclusions from information presented (ELS 3.1)

2.12

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Inspect data tables or charts to find systematic changes in a variable	a Use the results of analyzing data to interpret an investigation	a Use the results of analyzing data to interpret an investigation	a Use the results of analyzing data (e.g., classifying, inferring, using numbers) to interpret the meaning and significance of an investigation (ELS 6.4)
b Evaluate whether a simple written or oral inference is consistent with known data (ELS 6.4)	b Evaluate whether a simple written or oral inference is consistent with known data (ELS 6.4)	b Compare the results of experiment data analysis to the expected results and determine the reasons for the differences	b Compare the results of experiment data analysis to the expected results and determine the reasons for the differences (ELS 6.4)
c Draw logical conclusions from information presented (ELS 3.1)	c Draw logical conclusions from information presented (ELS 3.1)	c Draw logical conclusions from information presented (ELS 3.1)	c Draw logical conclusions from information presented (ELS 3.1)

2.11

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Design methods for controlling selected variables	a Design methods for controlling selected variables	a Design methods for controlling selected variables	a Design an experiment based on individual choice of variables
b Draw logical conclusions from information presented (ELS 3.1)	b Draw logical conclusions from information presented (ELS 3.1)	b Draw logical conclusions from information presented (ELS 3.1)	b Draw logical conclusions from information presented (ELS 3.1)

2.12

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Use the results of analyzing data (e.g., classifying, inferring, using numbers) to interpret the meaning and significance of an investigation	a Recognize a pattern or other meaning inherent in a collection of data which leads to stating a generalization or developing a hypothesis	a Recognize a pattern or other meaning inherent in a collection of data which leads to stating a generalization or developing a hypothesis	a Evaluate conflicting data
b Compare the results of experiment data analysis to the expected results and determine the reasons for the differences	b Interpret discrepancies or correspondence between anticipated results (hypothesis) and actual results of an investigation they have performed	b Interpret discrepancies or correspondence between anticipated results (hypothesis) and actual results of an investigation they have performed (ELS 6.2)	b Describe and evaluate the changes in an experiment which might give the expected results
c Draw logical conclusions from information presented (ELS 3.1)	c Synthesize information and draw conclusions (ELS 3.1)	c Synthesize information and draw conclusions (ELS 3.1)	c Synthesize information and draw conclusions (ELS 3.1)

2.13 PREDICT: USE INFORMATION AND DATA TO GENERATE AND TEST PREDICTIONS (ELS 1.6 and 6.2)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
		[a] Use prior experience to generate a prediction and direct experience to test it	[a] Use observations already made, to predict new observations (e.g., if a candle flame is extinguished when covered by a jar 3 times, it should go out when covered a fourth time) (ELS 6.2)	[a] Use observations already made, to predict new observations (e.g., if a candle flame is extinguished when covered by a jar 3 times, it should go out when covered a fourth time) (ELS 6.2)

2.14 FORMULATE MODELS: USE PROBLEM-SOLVING AND QUESTIONING SKILLS TO DEVELOP MENTAL MODELS THAT EXPLAIN PHENOMENA (ELS 6.3)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

2.15 COMMUNICATE: USE A VARIETY OF TECHNIQUES TO SHARE THE RESULTS OF INVESTIGATIONS (ELS 1.6 and 2.3)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
[a] Share information about science activities	[a] Share information about investigations	[a] Share information about investigations	[a] Share information orally and pictorially and in writing about investigations (ELS 2.3)	[a] Share information about investigations using oral, written and visual communication skills (ELS 1.6 and 2.3)

2.13

GRADE 5	GRADE 6	GRADE 7	GRADE 8
[a] Make predictions based on the systematic changes found in a data table or chart (e.g., use the chart to predict the time a burning candle would be extinguished in a closed container) (ELS 1.6)	[a] Make predictions based on the systematic changes found in a data table or chart (e.g., use the chart to predict the time a burning candle would be extinguished in a closed container) (ELS 1.6)	[a] Use quantitative measurement as a means of improving accuracy of predictions (ELS 1.6)	[a] Use quantitative measurement as a means of improving accuracy of predictions (ELS 1.6)

2.14

GRADE 5	GRADE 6	GRADE 7	GRADE 8
	[a] Create visual representations of an object, system or event which cannot be directly observed	[a] Create visual representations of an object, system or event which cannot be directly observed	[a] Create verbal and visual representations of an object, system or event which cannot be directly observed (e.g., interior structure of the earth, black box)

2.15

GRADE 5	GRADE 6	GRADE 7	GRADE 8
[a] Share information about investigations by applying oral, written and visual (e.g., graphs) communication skills (ELS 1.6 and 2.3)	[a] Share information about investigations by applying oral, written and visual (e.g., graphs) communication skills (ELS 1.6 and 2.3)	[a] Share information about investigations through oral, written and visual (e.g., graphs, charts) communication skills (ELS 1.6 and 2.3)	[a] Share information about investigations through oral, written and visual (e.g., graphs, charts) communication skills (ELS 1.6 and 2.3)

2.13

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Compare predictions made from few observations to those made from many	a Establish confidence levels for accepting or rejecting predictions (ELS 1.6)	a Establish confidence levels for accepting or rejecting predictions (ELS 1.6, 3.1 and 6.2)	a Evaluate the validity of predictions

2.14

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Explain how a system functions based on indirect evidence (e.g., black box)	a Explain how a system functions based on indirect evidence (e.g., black box)	a Describe a closed interacting system based on observation and tests (e.g., a closed box system)	a Evaluate the importance of models in science and society
b List additional changes or observations that might change a model	b List additional changes or observations that might change a model	b Use simulation to show changes in demographics (e.g., computer models, change in populations)	b Evaluate how changes in observations affect models
	c Compare different models of the same phenomenon	c Compare different models of the same phenomenon	

2.15

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Share information about investigations through oral, written and visual (e.g., graphs, charts) communication skills (ELS 1.6 and 2.3)	a Share information about investigations through oral, written and visual (e.g., graphs, charts) communication skills (ELS 1.6 and 2.3)	a Present and explain the results of investigations to groups, using oral, written and visual (e.g., graphs, charts) communication skills (ELS 1.6 and 2.3)	a Present, explain and evaluate the results of investigations to groups, using oral, written and and visual (e.g., charts, graphs) communication skills (ELS 1.6 and 2.3)

Manipulative Skills

Students use a variety of materials and equipment in a safe and scientific way. The practice of appropriate and positive safety behaviors will enhance learning while students construct equipment or apparatus necessary for scientific activities. Student-developed activities can provide students with an opportunity to experience a concept through invention and discovery lessons.

3.0 Manipulative Skills. Students use a variety of materials and equipment in a safe and scientific way.

3.1 CONSTRUCT: SET UP, SHAPE OR BUILD THE EQUIPMENT AND APPARATUS NECESSARY FOR SCIENTIFIC ACTIVITIES (E.G., GRID SQUARES, MICROSCOPE SLIDES, GLASSWARE)*

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
			a Build model parts of the environment (e.g., trees, mountains, buildings, school playground)	a Assemble materials and build simple models or apparatus b Design a working model to fit a specific purpose
c Explore the properties of different materials	c Explore the properties of different materials	c Explore the properties and uses of different materials	c Explore the properties and uses of different materials	c Explore the properties and uses of different materials d Test and evaluate design according to original criteria e Modify design based on evaluation

3.1

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Select and assemble materials for a science activity (e.g., bird houses, feeders, insect displays, rearing chambers, models)	a Select and assemble equipment or apparatus to conduct a science activity (e.g., soil studies, plant growth, seed dispersal)	a Select and assemble equipment or apparatus to conduct a science activity (e.g., changes in state of matter)	a Select, assemble or construct equipment or apparatus to conduct a science activity
b Design a working model to fit a specific purpose	b Design a working model to fit a specific purpose		
c Research and select materials and tools appropriate for building a working model	c Research and select materials and tools appropriate for building a working model		
d Test and evaluate design according to original criteria	d Test and evaluate design according to original criteria		
e Modify design based on evaluation	e Modify design based on evaluation		

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3.1

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Select, assemble, or construct equipment or apparatus to conduct a science activity	[a] Select, assemble, or construct equipment or apparatus to conduct a science activity	[a] Select, assemble or construct equipment or apparatus to conduct a science activity	[a] Select, assemble or construct equipment or apparatus to conduct a science activity
		[b] Design apparatus and a system that can be used easily by others to perform specific experiments	[b] Design apparatus and a system that can be used easily by others to perform specific experiments

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3.2 HANDLE MATERIALS: DEMONSTRATE THE PROPER SAFE USE AND MAINTENANCE OF LABORATORY EQUIPMENT AND MATERIALS (E.G., POINTED SCISSORS, SAFETY GLASSES, MICROSCOPES, CHEMICALS, POWER TOOLS, LIVING MATERIALS, MODELS, MEASURING DEVICES)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
			[a] Describe cause and effect relationships in safety procedures, maintenance and storage	[a] Develop an awareness of the importance of handling hazardous material safely
				[b] List rules for safe hands-on experimental practices
[c] Use and maintain science materials properly and safely	[c] Use and maintain science materials properly and safely	[c] Use and maintain science materials properly and safely	[c] Use and maintain science materials properly and safely	[c] Use and maintain science materials properly and safely
[d] Match simple tools to their functions	[d] Choose appropriate tools for specific task and material	[d] Choose appropriate tools for specific task and material	[d] Choose appropriate tools for specific task and material	[d] Choose appropriate tools for specific task and material

3.3 PRACTICE BEHAVIOR: PRACTICE APPROPRIATE AND POSITIVE HEALTH BEHAVIORS TO ENHANCE LEARNING (ELS 7.4)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] List how substance use can affect mental and physical performance

3.2

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Develop an awareness of handling equipment and disposal of hazardous materials	a Observe proper techniques for handling equipment and disposal of hazardous materials	a Use proper techniques when handling equipment and disposing of hazardous materials	a Use proper techniques when handling equipment and disposing of hazardous materials
b Develop rules establishing safe hands-on experimental practices	b Learn rules establishing safe hands-on experimental practices	b Learn rules establishing safe hands-on experimental practices and use appropriate safety equipment	b Use appropriate safety equipment (e.g., clothes, eye protection, hearing protection, fire control equipment)
c Use and maintain science materials properly and safely	c Use and maintain science materials properly and safely	c Demonstrate proper technique for common laboratory skills (e.g., heating, filtering, using a balance)	c Demonstrate proper technique for common laboratory skills (e.g., heating, filtering, using a balance)
d Choose appropriate tools for specific task and material	d Choose appropriate tools for specific task and material	d Choose appropriate tools for specific task and material	d Choose appropriate tools for specific task and material

3.3

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Explain how substance use can produce healthful or harmful effects on mental and physical performance (e.g., gathering data during an investigation, frequency of accidents) (ELS 7.4)	a Explain how substance use can produce healthful or harmful effects on mental and physical performance (e.g., gathering data during an investigation, frequency of accidents) (ELS 7.4)	a Explain how substance use can produce healthful or harmful effects on mental and physical performance (e.g., gathering data during an investigation, frequency of accidents) (ELS 7.4)	a Evaluate the effects of substance use on physical and mental performance (e.g., recording accurate measurements during an investigation, frequency of accidents) (ELS 7.4)

3.2

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Use proper techniques when handling equipment and disposing of hazardous materials	a Use proper techniques when handling equipment and disposing of hazardous materials	a Use proper techniques when handling equipment and disposing of hazardous materials	a Relate laboratory chemical disposal to disposal chain of school, community, nation and planet
b Use appropriate safety equipment (e.g., clothes, eye protection, hearing protection, fire control equipment)	b Use appropriate safety equipment (e.g., clothes, eye protection, hearing protection, fire control equipment)	b Use appropriate safety equipment (e.g., clothes, eye protection, hearing protection, fire control equipment)	b Evaluate school environment for safety concerns (e.g., fire exit routes identified, ventilation of science classrooms, chemical storage)
c Demonstrate proper techniques in use of all laboratory apparatus (e.g., microscope, buret, electronic balance, voltmeter)	c Demonstrate proper techniques in use of all laboratory apparatus (e.g., microscope, buret, electronic balance, voltmeter)	c Demonstrate proper techniques in use of all laboratory apparatus (e.g., microscope, buret, electronic balance, voltmeter)	c Demonstrate proper techniques in use of all laboratory apparatus (e.g., microscope, buret, electronic balance, voltmeter)
d Choose appropriate tools for specific task and material	d Choose appropriate tools for specific task and material	d Choose appropriate tools for specific task and material	d Choose appropriate tools for specific task and material

3.3

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Evaluate the effects of substance use on physical and mental performance (e.g., recording accurate measurements during an investigation, frequency of accidents) (ELS 7.4)	a Evaluate the effects of substance use and how it effects safety of self and others in the laboratory (e.g., using manipulative devices, handling chemicals) (ELS 7.4)	a Apply information and skills concerning substance use which will enhance physical and mental performance (e.g., using laboratory measuring devices, handling chemicals) (ELS 7.4)	a Evaluate the overall effect of the widespread use of substances on the functioning of a highly technical society (e.g., where mistakes can be very dangerous and far-reaching)

Interests

Students develop interest in science. Student interest in science is enhanced when participation in and understanding scientific things at the students' own level of sophistication leads to gaining confidence.

Learning from many sources (e.g., reading, watching, visiting); wanting and giving scientific explanations by preferring systematic and exact explanations to nonscientific ones, if the former are at the appropriate levels of sophistication; finding avocations (e.g., photography, shell collecting, constructing apparatus) that are rewarding; and exploring vocations when considering science-related careers, all can contribute significantly to the development of the students' interest in science.

4.0 Interests. Students develop interest in science.

4.1 DEVELOP VOCATIONAL AND AVOCATIONAL INTERESTS IN SCIENCE BY USING MANY SOURCES (E.G., MEDIA, ORGANIZATIONS, CONDUCTING OWN RESEARCH ACTIVITY IN AND BEYOND THE CLASSROOM)* (ELS 7.2)**

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
[a] Explore a variety of resources in pursuit of individual interests related to science	[a] Explore a variety of resources in pursuit of individual interests related to science	[a] Explore a variety of resources in pursuit of individual interests related to science	[a] Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews) in pursuit of individual interests related to science (ELS 7.2)	[a] Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases) in pursuit of individual interests related to science (ELS 7.2) [b] Use library classification system and services to locate specialized resources (e.g., people with expertise, print and nonprint, places of interest and information) (ELS 7.2)
[c] Share a science interest with others	[c] Share a science interest with others	[c] Share a science interest with others	[c] Share a science interest with others	[c] Share a science interest with others

4.2 RECOGNIZE WORDS AND SYMBOLS COMMONLY USED IN WRITTEN MATERIALS (ELS 1.1)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
[a] Recognize and use common words and symbols	[a] Recognize and use common words and symbols	[a] Recognize and use common words and symbols	[a] Recognize and use common words and symbols	[a] Recognize and use common words and symbols found in written materials (ELS 1.1)

4.1

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases) in pursuit of individual interests related to science (ELS 7.2)	a Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases) in pursuit of individual interests related to science (ELS 7.2)	a Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases) in pursuit of individual interests related to science (ELS 7.2)	a Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases) in pursuit of individual interests related to science (ELS 7.2)
b Use library classification system and services to locate specialized resources (e.g., people with expertise, print and nonprint, places of interest and information) (ELS 7.2)	b Use library classification system and services to locate specialized resources (e.g., people with expertise, print and nonprint, places of interest and information) (ELS 7.2)	b Use library classification system and services to locate specialized resources (e.g., people with expertise, print and nonprint, places of interest and information) (ELS 7.2)	b Use library classification system and services to locate specialized resources (e.g., people with expertise, print and nonprint, places of interest and information) (ELS 7.2)
c Describe several science vocations and avocations	c Describe several science vocations and avocations	c Identify aspects of science which relate to vocational and avocational interests	c Identify aspects of science which relate to vocational and avocational interests

4.2

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Recognize and use common words and symbols found in written materials (ELS 1.1)	a Recognize and use common words and symbols found in written materials (ELS 1.1)	a Recognize and use common words and symbols found in written materials (ELS 1.1)	a Recognize and use common words and symbols found in written materials (ELS 1.1)

4.1

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases) in pursuit of individual interests related to science (ELS 7.2)	a Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases) in pursuit of individual interests related to science (ELS 7.2)	a Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases) in pursuit of individual interests related to science (ELS 7.2	a Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases, job training) in pursuit of individual interests related to science (ELS 7.2)
b Use library classification system and services to locate specialized resources (e.g., people with expertise, print and nonprint, places of interest and information) (ELS 7.2)	b Use library classification system and services to locate specialized resources (e.g., people with expertise, print and nonprint, places of interest and information) (ELS 7.2)	b Use library classification system and services to locate specialized resources (e.g., people with expertise, print and nonprint, places of interest and information) (ELS 7.2)	b Use library classification system and services to locate specialized resources (e.g., people with expertise, print and nonprint, places of interest and information) (ELS 7.2)
c Identify science courses and resources which will enhance vocational and avocational interests	c Identify science courses and resources which will enhance vocational and avocational interests	c Identify science courses and resources which will enhance vocational and avocational interests	c Identify science courses and resources which will enhance vocational and avocational interests

4.2

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Recognize and use common words and symbols found in written materials (ELS 1.1)	a Recognize and use common words and symbols found in written materials (ELS 1.1)	a Recognize and use common words and symbols found in written materials (ELS 1.1) b Define operationally common science terms related to science concepts	a Recognize and use common words and symbols found in written materials (ELS 1.1)

4.3 DETERMINE MEANING OF UNKNOWN WORDS AND SYMBOLS COMMONLY USED IN INSTRUCTIONAL MATERIALS (ELS 1.2)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
[a] Use a variety of experiences to form the understanding of a concept	[a] Use a variety of experiences to form the understanding of a concept	[a] Use a variety of experiences to form the understanding of a concept	[a] Use concrete (hands-on) experiences as a basis for determining meaning of terms (i.e., define operationally) [b] Use dictionaries, glossaries, media and other reference materials to find word and symbol meanings (ELS 1.2)	[a] Use concrete (hands-on) experiences as a basis for determining meaning of terms (i.e., define operationally) [b] Use dictionaries, glossaries, media and other reference materials to find word and symbol meanings (ELS 1.2)

4.4 USE INSTRUCTIONAL MATERIALS AS BASIS FOR GAINING KNOWLEDGE AND IMPROVING COMPREHENSION (ELS 2.2)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
			[a] Use table of contents to locate general and specific information (ELS 2.2)	[a] Use table of contents and index to locate general and specific information (ELS 2.2) [c] Use current technology (e.g., videotape, computer) to locate information needed

4.3

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Use concrete (hands-on) experiences as a basis for determining meaning of terms (i.e., define operationally)	a Use concrete (hands-on) experiences as a basis for determining meaning of terms (i.e., define operationally)	a Use concrete (hands-on) experiences as a basis for determining meaning of terms (i.e., define operationally)	a Use concrete (hands-on) experiences as a basis for determining meaning of terms (i.e., define operationally)
b Use dictionaries, glossaries, media, and other reference materials to find word and symbol meanings (ELS 1.2)	b Use dictionaries, glossaries, media, and other reference materials to find word and symbol meanings (ELS 1.2)	b Use dictionaries, glossaries, media, and other reference materials to find word and symbol meanings (ELS 1.2)	b Use dictionaries, glossaries, media, and other reference materials to find word and symbol meanings (ELS 1.2)
		c Utilize affixes and root words in understanding meaning of scientific and technological terms	c Utilize affixes and root words in understanding meaning of scientific and technological terms

4.4

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Use table of contents and index to locate general and specific information (ELS 2.2)	a Use table of contents, index, summaries, charts, graphs, and illustrations to locate information needed (ELS 2.2)	a Use table of contents, index, summaries, charts, graphs, and illustrations to locate information needed (ELS 2.2)	a Use table of contents, index, summaries, charts, graphs, and illustrations to locate information needed (ELS 2.2)
b Use supportive illustrations, detail and summations to obtain information (ELS 2.2)	b Use organization of materials (summaries, headings and review questions) for preview and review (ELS 2.2)	b Use organization of materials (summaries, headings and review questions) for preview and review (ELS 2.2)	b Use organization of materials (summaries, headings and review questions) for preview and review (ELS 2.2)
c Use current technology (e.g., videotape, computer accessed data bases, video disc) to locate information needed	c Use current technology (e.g., videotape, computer accessed data bases, video disc) to locate information needed	c Use current technology (e.g., videotape, computer accessed data bases, video disc) to locate information needed	c Use current technology (e.g., videotape, computer accessed data bases, video disc) to locate information needed

4.3

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Use concrete (hands-on) experiences as a basis for determining meaning of terms (i.e., define operationally)	a Use concrete (hands-on) experiences as a basis for determining meaning of terms (i.e., define operationally)	a Use concrete (hands-on) experiences as a basis for determining meaning of terms (i.e., define operationally)	a Recognize that the meaning of terms are tentative, subject to experience
b Use dictionaries, glossaries, media, and other reference materials to find word and symbol meanings (ELS 1.2)	b Use standard and scientific dictionaries, glossaries, handbooks and definitions in footnotes to find word meanings (ELS 1.2)	b Use standard and scientific dictionaries, glossaries, handbooks and definitions in footnotes to find word meanings (ELS 1.2)	b Use standard and scientific dictionaries, glossaries, handbooks and definitions in footnotes to find word meanings (ELS 1.2)
c Utilize affixes and root words in understanding meaning of scientific and technological terms	c Utilize affixes and root words in understanding meaning of scientific and technological terms	c Utilize affixes and root words in understanding meaning of scientific and technological terms	c Utilize affixes and root words in understanding meaning of scientific and technological terms

4.4

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Use table of contents, index, summaries, charts, graphs, and illustrations to locate information needed (ELS 2.2)	a Use and interpret a variety of written resources (e.g., charts, graphs, tables) to locate information needed (ELS 2.2)	a Use and interpret a variety of written resources (e.g., charts, graphs, tables) to locate information needed (ELS 2.2)	a Use and interpret a variety of written resources (e.g., charts, graphs, tables) to locate information needed (ELS 2.2)
b Use organization of materials (summaries, headings and review questions) for preview and review (ELS 2.2)	b Use organization of materials (summaries, headings and review questions) for preview and review (ELS 2.2)	b Use organization of materials (summaries, headings and review questions) for preview and review (ELS 2.2)	b Use organization of materials (summaries, headings and review questions) for preview and review (ELS 2.2)
c Use current technology (e.g., videotape, computer accessed data bases, video discs) to locate information needed	c Use current technology (e.g., videotape, computer accessed data bases, video discs) to locate information needed	c Use current technology (e.g., videotape, computer accessed data bases, video discs) to locate information needed	c Use current technology (e.g., videotape, computer accessed data bases, video discs) to locate information needed

Values

Students apply values that underlie science. By directing inquiry toward knowledge as a worthy investment of time and other resources, knowing and understanding will be valued. Questioning all things, searching for data and meaning, demanding verification, respecting logic, and considering the consequences of actions to be taken are values that students of science will be able to apply.

5.0 Values. Students apply the values that underlie science.

5.1 RECOGNIZE THAT SEEKING KNOWLEDGE AND UNDERSTANDING IS A WORTHY INVESTMENT OF TIME AND RESOURCES* (ELS 6.2 and 6.3)**

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
a Share information and understanding with others	a Share information and understanding with others	a Share information and understanding with others	a Share information and understanding with others	a Gather, organize and report new information
			b Explain the importance of information obtained through personal experience	b Explain the importance of information obtained through personal experience
			c Explain the importance of information obtained from others	c Explain the importance of information obtained from others

5.2 QUESTION INFORMATION AND IDEAS BY DETERMINING THEIR SIGNIFICANCE AND ACCURACY AS PRESENTED IN WRITTEN, ORAL, AURAL AND VISUAL COMMUNICATIONS (E.G., LISTENING, READING, VIEWING, EVALUATING PRESENTATIONS OF MASS MEDIA) (ELS 4.4 and 6.4)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

5.1

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Evaluate new information	a Evaluate new information	a Recognize the importance of securing and evaluating information	a Recognize the importance of securing and evaluating information
b Evaluate personal knowledge and knowledge of others	b Decide what information is needed to make decisions	b Prioritize the relevance of information needed to make decisions	b Evaluate the worth of information needed to make decisions
			c Interpret differences between two explanations (ELS 6.2)

5.2

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Distinguish between relevant and irrelevant information used to draw conclusions	a Distinguish between relevant and irrelevant information used to draw conclusions	a Distinguish between relevant and irrelevant information used to draw conclusions	a Distinguish between relevant and irrelevant information used to draw conclusions
b Determine a strategy for determining whether a statement is a fact (ELS 6.4)	b Determine a strategy for determining whether a statement is a fact (ELS 6.4)	b Determine a strategy for determining whether a statement is a fact (ELS 6.4)	b Analyze information obtained through personal experience
c Evaluate whether a simple written or oral conclusion is consistent with known facts	c Evaluate whether a simple written or oral conclusion is consistent with known facts	c Evaluate whether a simple written or oral conclusion is consistent with known facts	c Analyze information obtained by others
		d Distinguish between evidence and opinion	d Evaluate whether a conclusion is based on evidence or opinion (ELS 6.4)
e Listen, read and view critically (ELS 4.4)	e Listen, read and view critically (ELS 4.4)	e Listen, read and view critically (ELS 4.4)	e Listen, read and view critically (ELS 4.4)
	f Identify influences of mass media upon self and society	f Identify influences of mass media upon self and society	f Recognize elements and identify influences of mass media upon self and society (ELS 4.4)
			g Critically evaluate mass media influences (ELS 4.4)

5.1

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Recognize the importance of securing and evaluating information	a Apply knowledge and understanding in new situations	a Apply knowledge and understanding in new situations	a Exhibit a desire to invest personal time in seeking new information and understanding
b Evaluate the worth of information needed to make decisions	b Analyze explanations and interpretations to confirm or validate them	b Analyze explanations and interpretations to confirm or validate them	

5.2

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Distinguish between relevant and irrelevant information used to draw conclusions	a Distinguish between relevant and irrelevant information used to draw conclusions	a Distinguish between relevant and irrelevent information used to draw conclusions	a Distinguish between relevant and irrelevant information used to draw conclusions
b Critically evaluate arguments or positions in terms of known facts (ELS 6.4)	b Critically evaluate arguments or positions in terms of known facts (ELS 6.4)	b Critically evaluate arguments or positions in terms of known facts (ELS 6.4)	b Critically evaluate arguments or positions in terms of known facts (ELS 6.4)
c Evaluate the significance and accuracy of information	c Evaluate the significance and accuracy of information	c Evaluate the significance and accuracy of information	c Evaluate the significance and accuracy of information
		d Distinguish between nonscience and the unknown or unanswerable	
e Listen, read and view critically (ELS 4.4)	e Listen, read and view critically (ELS 4.4)	e Listen, read and view critically (ELS 4.4)	e Listen, read and view critically (ELS 4.4)
		f Evaluate roles of mass media in society (ELS 4.4)	

5.2 QUESTION INFORMATION AND IDEAS BY DETERMINING THEIR SIGNIFICANCE AND ACCURACY AS PRESENTED IN WRITTEN, ORAL, AURAL AND VISUAL COMMUNICATIONS (E.G., LISTENING, READING, VIEWING, EVALUATING PRESENTATIONS OF MASS MEDIA) (ELS 4.4 and 6.4) (continued)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

5.3 RECOGNIZE THE IMPORTANCE OF SYSTEMATICALLY ACQUIRING AND ORDERING DATA AS THE BASIS FOR SCIENTIFIC EXPLANATIONS AND THEORIES (ELS 6.4)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

5.2

GRADE 5	GRADE 6	GRADE 7	GRADE 8
			h Identify appropriate types of information (e.g., qualitative, quantitative) that should be included in simple forms of communication
		i Evaluate whether a simple written conclusion is consistent with known facts	i Evaluate whether a simple written or oral conclusion is consistent with known facts
			j Recognize persuasion techniques found in audio and visual communications (ELS 4.4)

5.3

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Recognize the relationship between the data acquired and scientific explanation or theory (e.g., give examples of real data which support an explanations or theory)	a Distinguish between systematically acquired data and nonsystematically acquired data	a Identify the characteristics of scientific explanations	a Distinguish between scientific and nonscientific explanations

5.2

GRADE 9	GRADE 10	GRADE 11	GRADE 12
h Identify appropriate types of information (e.g., qualitative, quantitative) that should be included in simple forms of communication	h Identify appropriate types of information (e.g., qualitative, quantitative) that should be included in simple forms of communication	h Identify appropriate types of information (e.g., qualitative, quantitative) that should be included in simple forms of communication	
i Evaluate whether a simple written or oral conclusions is consistent with known facts	i Evaluate whether a simple written or oral conclusions is consistent with known facts	i Evaluate whether a simple written or oral conclusion is consistent with known facts	
		j Recognize elements and use of propaganda techniques found in audio, printed and visual communications (ELS 6.4)	

5.3

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Identify the value of scientific and nonscientific explanations	a Recognize the need for systematic and exact explanation over a nonscientific explanation	a Recognize the need for systematic and exact explanation over a nonscientific explanation	a Evaluate the importance of data-based explanations
b Select and order data that supports a scientific explanation	b Explain the value of data in supporting a scientific explanation	b Explain the value of data in supporting a scientific explanation	b Explain the value of data in supporting a specific scientific explanation

5.4 RECOGNIZE THAT SCIENTIFIC EXPLANATIONS MUST BE REPLICABLE (E.G., SUPPORTING EVIDENCE OBTAINED BY OTHER INVESTIGATORS WORKING IN DIFFERENT PLACES AT DIFFERENT TIMES UNDER SIMILAR CONDITIONS) AND MADE PUBLIC IN ORDER TO BE ACCEPTED AS VALID (ELS 5.3)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

5.5 APPLY LOGIC BY REFLECTING UPON AND IMPROVING ~~OWN REASONING~~ (ELS 6.6)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
			[a] Describe in simple terms how a solution was reached (ELS 6.6)	[a] Describe in simple terms how a solution was reached (ELS 6.6) [b] Recognize that people have biases

5.4

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Use data collected from other students to verify their own results in an investigation	a Use data collected from other students to verify their own results in an investigation	a Verify data collected from other students by replicating an investigation and comparing the results	a Verify data collected from other students by replicating an investigation and comparing the results

5.5

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Describe the reasoning process most frequently being used in terms of inductive or deductive reasoning (ELS 6.6)	a Participate in inductive and deductive reasoning activities	a Use inductive and deductive reasoning given problems and data specific to each form of logic	a Use inductive and deductive reasoning given problems and data specific to each form of logic
b State rationale for people having biases (ELS 6.6)	b Identify personal biases	b Explain personal biases	b Explain personal biases (ELS 6.6)
c Identify authoritative sources for obtaining feedback about reasoning skills (ELS 6.6)	c Use feedback to improve reasoning skills	c Use feedback to improve reasoning skills	c Defend a position using logic

5.4

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Verify data collected from other students by replicating an investigation and comparing the results	a Verify data collected from other students by replicating an investigation and comparing the results	a Seek ways of verifying ideas through experimentation and research	a Evaluate methods of verifying ideas (i.e., indirect testing of hypotheses)
		b Evaluate, on an ongoing basis, the strengths and weaknesses of ideas and theories based on new information	b Evaluate, on an ongoing basis, the stregths and weaknesses of ideas and theories based on new information
c Explain the importance of validation of scientific explanations and possible consequences if this did not occur	c Explain the importance of validation of scientific explanations and possible consequences if this did not occur	c Explain the importance of validation of scientific explanations and possible consequences if this did not occur	c Evaluate the importance of validation of scientific explanations

5.5

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Use inductive and deductive reasoning given problems and data specific to each form of logic	a Use inductive and deductive reasoning given problems and data specific to each form of logic	a Present arguments supporting the use of deductive or inductive reasoning for a particular purpose (ELS 6.6)	a Present arguments supporting the use of deductive or inductive reasoning for a particular purpose (ELS 6.6)
b Give examples where biases affect reasoning	b Give examples where biases affect reasoning	b Evaluate when bias, inconsistency or other weaknesses affect reasoning (ELS 6.6)	b Evaluate when bias, inconsistency or other weaknesses affect reasoning (ELS 6.6)
c Defend a position using logic	c Defend a position using logic	c Defend position when criticized by an authority who is biased (ELS 6.6)	c Analyze a biased authority's position

5.6 RECOGNIZE THE IMPORTANCE OF CONSIDERING THE CONSEQUENCES (E.G., POSSIBLE, ACTUAL) OF INVESTIGATIONS AND ACTIONS BEFORE DECIDING TO CONTINUE, CHANGE, OR STOP THE PROCESS

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Recognizes that there are consequences to choices

GRADE 5	GRADE 6	GRADE 7	GRADE 8
[a] Recognize consequences of own personal choices	[a] Recognize consequences of own personal choices at school	[a] Recognize consequences of own personal choices in the community	a Trace consequences of human intervention in natural cycles

5.6

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Recognize the consequences of personal choice regarding the environment	a Recognize the consequences of personal choice regarding the environment	a Evaluate the consequences of action taken	a Evaluate the consequences of action taken
b Recognize the value of predicing consequences of action taken	b Recognize the value of predicing consequences of action taken	b Recognize the value of predicing consequences of action taken	b Predict and evaluate consequences of a proposed action
c Describe the consequences of scientific research (e.g., nuclear engineering, smoking)	c Describe the consequences of scientific research (e.g., nuclear engineering, smoking)	c Determine if action should continue with a given scientific study after considering the possible consequences (e.g., hydrogen nuclear fission, genetic engineering, human clothing)	c Determine if action should continue with a given scientific study after considering the possible consequences (e.g., hydrogen nuclear fission, genetic engineering, human clothing)

Interactions

Students describe interactions among science, society, technology and earth's environment. Societies influence what science investigates and technology develops; society — including scientists and technologists — ultimately determines how science is applied. Science's influence is exerted when scientists open-mindedly and steadfastly investigate what society may **think** irrelevant or trivial, though it may take time for society to realize the benefits; even when realized, some benefits may have undesirable side effects, trade-offs.

Scientists, technologists and educators owe the public clear and timely information; the public in turn needs to pay attention, to question and to realize scientists may disagree because they interpret data differently.

Due to the limitations of science, science cannot solve all of society's problems; solutions may be impossible, some may defy scientific methods, none can be legislated, bought or guaranteed.

6.0 Interactions. Students describe interactions among science, society, technology and earth's environment.

6.1 DESCRIBE HOW SOCIETY INFLUENCES SCIENCE AND TECHNOLOGY* (Technology includes inventions plus systems and rules designed for using those inventions, i.e., hard and soft technology)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Identify technology that has been developed

6.2 DESCRIBE HOW SCIENCE AND TECHNOLOGY INFLUENCE SOCIETY

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
	[a] Identify products of technology and how they affect us personally (e.g., television)	[a] Identify products of technology and how they affect us personally (e.g., television)	[a] Identify technology that is used and how it helps society	[a] Identify scientific knowledge that is used and how it helps society (e.g., knowledge of the causes of cancer) [b] Recognize how individual wants and needs are influenced by technology

6.1

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Identify technology which has been developed or improved because people wanted it (e.g., styrofoam cups)	a Identify technology development which has been resisted by society	a Identify reasons for societal demands on science and technology	a Recognize demands of society which influence science and technology
b Identify technology which has been developed or improved to help people (e.g., kidney dialysis machine)	b Identify technology which has been developed to help improve learning	b Identify the cost (e.g., monetary, societal) involved in the production of a new technology	b Recognize that society controls science and technology through the allocation of resources

6.2

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Recognize how individual wants and needs are positively and negatively influenced by scientific knowledge	a Recognize how individual wants and needs are positively and negatively influenced by scientific knowledge	a Recognize how individual wants and needs are positively and negatively influenced by scientific knowledge	a Recognize how scientific knowledge influences societies' attitudes
b Recognize how individual wants and needs are influenced by technology	b Recognize how individual wants and needs are influenced by technology	b Recognize how individual wants and needs are positively and negatively influenced by technology	b Recognize how individual wants and needs are positively and negatively influenced by technology
		c Identify scientific and technological developments which have positively and negatively affected individuals	c Identify scientific and technological developments which have positively and negatively affected society

6.1

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Recognize demands of society which influence science and technology	a Recognize demands of society which influence science and technology	a Describe how society's support influences science and technology	a Evaluate how much society should control science and technology's impact (e.g., getting rid of ozone-destroying styrofoam cups)
b Recognize that society controls science and technology through the allocation of resources	b Describe why it can be important for society to support pure scientific research which has no apparent or immediate applications, but simply seeks to find answers to questions or test hypotheses	b Describe why it can be important for society to support pure scientific research which has no apparent or immediate applications, but simply seeks to find answers to questions or test hypotheses	b Evaluate the costs (e.g., monetary and societal) involved in the development of a new technology

6.2

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Recognize how scientific knowledge influences societies' attitudes	a Identify examples of how scientific knowledge has helped in the solution of societal problems	a Identify examples of how scientific knowledge has helped in the solution of societal problems	a Evaluate how scientific knowledge has been unable to solve some long-term problems of society (e.g., poverty, war, injustice, the imperfection of humans)
b Recognize how individual wants and needs are positively and negatively influenced by technology	b Recognize how individual wants and needs are positively and negatively influenced by technology	b Recognize how individual wants and needs are positively and negatively influenced by technology	b Recognize how individual wants and needs are positively and negatively influenced by technology
c Identify scientific and technological developments which have positively and negatively affected society	c Identify scientific and technological developments which have positively and negatively affected society	c Describe specific scientific and technological developments and how they have positively affected society	c In general, predict possible positive and negative effects of current emergent technology
		d Describe specific scientific and technological developments and how they have negatively affected society	

6.3 RECOGNIZE THE LIMITATIONS AS WELL AS THE USEFULNESS OF SCIENCE AND TECHNOLOGY IN ADVANCING HUMAN WELFARE

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[a] Recognize that all consequences of science cannot be anticipated

6.4 DESCRIBE AND PREDICT THE EFFECTS OF SCIENCE, SOCIETY AND TECHNOLOGY ON THE EARTH'S ENVIRONMENT AND ITS ABILITY TO SUPPORT ALL FORMS OF LIFE

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
	[a] Identify the basic environmental needs of humans and other organisms (e.g., plants, animals)	[a] Identify the basic environmental needs of humans and other organisms (e.g., plants, animals)	[a] Identify the basic environmental needs of humans and other organisms (e.g., plants, animals)	[a] Describe how specific scientific and technological advances have affected the earth's environment and its ability to support life (e.g., ozone layer, automobiles, herbicides and pesticides, acid rain)
	[b] Identify ways humans can make the environment better for living things	[b] Identify ways humans can make the environment better for living things	[b] Identify how the recycling of waste can benefit people and the environment	[b] Ask questions about environmental problems and propose possible solutions (e.g., pollution: why? what will happen?)
	[c] Identify human behaviors that can be harmful to the environment	[c] Identify human behaviors that can be harmful to the environment	[c] Explore the impact of various wastes on the environment (e.g., grass clippings, styrofoam)	[c] Predict and measure the effects of a change on an environment (e.g., terrarium or aquarium soil composition, temperature, chemical, light)
				[d] Identify a source of pollution in your environment, investigate its possible effects and what could be done about it

6.3

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Recognize that all consequences of science cannot be anticipated	a Identify several consequences of science that were not anticipated	a Describe how science could be more responsible for consequences of its technology	a Recognize the physical factors that limit science (e.g., things that cannot be measured or observed)
			b Identify social problems which can and cannot be solved by scientific and technological advances (e.g., vaccines to prevent disease, human greed)

6.4

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Describe how specific scientific and technological advances have affected the earth's environment and its ability to support life (e.g., sewage treatment plants, automobile exhaust, pesticides)	a Describe how specific scientific and technological advances have affected the earth's environment and its ability to support life (e.g., sewage treatment plants, automobile exhaust, pesticides)	a Describe how specific scientific and technological advances have affected the earth's environment and its ability to support life (e.g., sewage treatment plants, automobile exhaust, pesticides)	a Describe how specific scientific and technological advances have affected the earth's environment and its ability to support life (e.g., sewage treatment plants, automobile exhaust, pesticides)
b Ask questions about environmental problems and propose possible solutions (e.g., pollution: why?, what will happen?)	b Ask questions about environmental problems and propose possible solutions (e.g., pollution: why?, what will happen?)	b Compare the effects of specific scientific and technological advances which have changed the earth's environment (e.g., automobiles, fertilizers)	b Compare the effects of specific scientific and technological advances which have changed the earth's environment (e.g., automobiles, fertilizers)
c Identify human caused changes their environment and investigate the possible effects	c Identify human caused changes their environment and investigate the possible effects	c Propose solutions to local environmental problems	c Propose solutions to local environmental problems

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6.3

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Recognize the physical factors that currently limit science (e.g., things that cannot now be measured or even observed reliably)	a Explore examples of the development of technology and techniques that have allowed the observation and measurement of things which couldn't previously be measured (e.g., the electron microscope)	a Recognize that data is being generated faster than it can be applied	a Speculate on how technological advances may be able to help manage amounts of data (e.g., artificial intelligence-directed data bases and logical correlation techniques)
b Identify social problems which can or cannot yet be solved by current and easily forseeable scientific and technological advances	b Predict ways in which science and technology may advance human welfare	b Predict ways in which science and technology may advance human welfare	b Predict ways in which science and technology might adversely affect human welfare

6.4

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Describe how specific scientific and technological advances have affected the earth's environment and its ability to support life (e.g., sewage treatment plants, automobile exhaust, pesticides)	a Describe how specific scientific and technological advances have affected the earth's environment and its ability to support life (e.g., sewage treatment plants, automobile exhaust, pesticides)	a Describe how specific scientific and technological advances have affected the earth's environment and predict how continued use or development may affect humans and other organisms	a Describe how specific scientific and technological advances have affected the earth's environment and predict how continued use or development may affect humans and other organisms
b Compare the effects of specific scientific and technological advances which have changed the earth's environment (e.g., automobiles, fertilizers)	b Explore the effects of science and technology and its influences on the local (i.e., school and home) personal environment	b Describe the difficulties involved in predicting the environmental changes associated with scientific and technological advances	b Describe the difficulties involved in predicting the environmental changes associated scientific and technological advances
c Propose solutions to local environmental problems	c Propose solutions to local environmental problems		

6.5 EVALUATE THE EXPLANATIONS BY SCIENTISTS, NEEDS OF SOCIETY AND POSSIBLE IMPACTS ON THE EARTH'S ENVIRONMENT TO MAKE RESPONSIBLE PERSONAL DECISIONS REGARDING THE USES OF TECHNOLOGY (ELS 6.4 and 6.5)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

GRADE 5	GRADE 6	GRADE 7	GRADE 8
			a Describe applications of technology and decisions entailed in its use
		b Identify reliable sources of scientific and technological information	b Identify reliable sources of scientific and technological information and use these sources in deciding a course of action
c State personal criteria for deciding whether to engage in or support a particular activity related to the environment (ELS 6.4)	c State personal criteria for deciding whether to engage in or support a particular activity related to the environment (ELS 6.4)	c State personal criteria for deciding whether to engage in or support a particular activity related to the environment (ELS 6.4)	c State personal criteria for deciding whether to engage in or support a particular activity related to the environment (ELS 6.4)
	d Take a position on an issue based on available information (ELS 6.5)	d Take a position on an issue based on available information (ELS 6.5)	d Take a position on an issue based on available information (ELS 6.5)
			e Support another person's position on an issue (e.g., through role playing, structured controversy techniques) (ELS 6.5)
			with a group to develop and position on a position or an social issue

GRADE 9	GRADE 10	GRADE 11	GRADE 12
a Describe applications of technology and decisions entailed in its use	a Describe applications of technology and decisions entailed in its use	a Describe applications of technology and decisions entailed in its use	a Describe applications of technology and decisions entailed in its use
b Identify reliable sources of scientific and technological information and use these sources in deciding a course of action	b Identify reliable sources of scientific and technological information and use these sources in deciding a course of action	b Analyze authoritative data to determine what optional positions are possible on a specific issue	b Use authoritative data to debate a specific environmental issue
c State personal criteria for deciding whether to engage in it or support a particular activity related to the environment (ELS 6.4)	c Compare the impact of a decision made by one individual with a similar decision made by a larger group	c Assess the worth of a given course of action or policy after considering its possible impacts on individual, society and the earth's environment (ELS 6.4)	c Evaluate past decisions and their effect on individual, society and the earth's environment
d Formulate, support and defend a position based upon data gathered from objective and authoritative sources (ELS 6.5)	d Formulate, support and defend a position based upon data gathered from objective and authoritative sources (ELS 6.5)	d Formulate, support and defend a position based upon data gathered from objective and authoritative sources (ELS 6.5)	d Formulate, support and defend a position based upon data gathered from objective and authoritative sources (ELS 6.5)
e Support another person's position on an issue (e.g., through role playing, structured controversy techniques) (ELS 6.5)	e Support another person's position on an issue (e.g., through role playing, structured controversy techniques) (ELS 6.5)	e Support another person's position on an issue (e.g., through role playing, structured controversy techniques) (ELS 6.5)	e Evaluate another person's position on an issue (e.g., political candidates)
f Work with a group to develop and agree upon a position on environmental issue	f Work with a group to develop and agree upon a position on environmental issue	f Work with a group to develop and agree upon a position on environmental issue	f Work with a group to develop and agree upon a position on environmental issue

Characteristics

Students describe the characteristics of scientific knowledge. Science is tentative since it is subject to change. It is not truth in an absolute and final sense.

Science is also public because other individuals could arrive at similar conclusions when confronted with the same evidence. It is replicable since other investigators working in different places at different times can gather similar evidence given similar conditions. Science is empirical because it tests hypotheses by experiment and observation after collecting data exactly, systematically, and objectively.

7.0 Characteristics. Students describe the characteristics of scientific knowledge.

7.1 DESCRIBE THE TENTATIVENESS OF SCIENTIFIC KNOWLEDGE (I.E., NOTION THAT IT IS SUBJECT TO CHANGE, NOT TRUTH IN AN ABSOLUTE AND FINAL SENSE)*

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4
				[b] Develop an awareness that science is not absolute

7.2 EXPLAIN THE IMPORTANCE OF OBJECTIVITY AND SUBJECTIVITY IN SCIENTIFIC THOUGHT, INCLUDING SIMILARITY OF CONCLUSIONS REACHED BY DIFFERENT INDIVIDUALS FROM THE SAME INFORMATION

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

7.3 ANALYZE SCIENTIFIC PREDICTIONS AND EXPLANATIONS FOR THEIR PROBABILITY (I.E., SCIENCE PERMITS REASONABLE BUT NOT CERTAIN PREDICTIONS AND EXPLANATIONS)

KINDERGARTEN	GRADE 1	GRADE 2	GRADE 3	GRADE 4

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7.1

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a Identify examples of historic changes in scientific knowledge	a Identify examples of historic changes in environmental knowledge	a Identify examples of historic changes in environmental knowledge	a Identify examples of historic changes in environmental, scientific and technological knowledge
b Develop an awareness that science is not absolute	b Develop an awareness that science is not absolute	b Develop an awareness that science is not absolute	b Identify new circumstances that could interfere with or change scientific explanations

7.2

GRADE 5	GRADE 6	GRADE 7	GRADE 8
a State conclusions from experimental data	a Define subjective and objective	a Identify objective and subjective aspects of an experiment and its conclusions	a Analyze an experiment or set of rules for the subjective and objective aspects

7.3

GRADE 5	GRADE 6	GRADE 7	GRADE 8

7.1

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Identify examples of historic changes in environmental scientific and technological knowledge [b] Display a preference for the tentative nature of science when discussing contradictory results	[a] Identify events and/or discoveries (i.e., change agents which have caused scientific models or theories to be altered)	[a] Identify change agents in examples (e.g., discoveries) of historic changes in scientific theories	[a] Evaluate the significance of change agents on modern science

7.2

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Give examples of the effects of subjectivity and objectivity on scientific thought	[a] Give examples of the historical role of subjectivity and objectivity in scientific thought	[a] Create options from collected data to test solutions for a problem (e.g., use objective and subjective approaches)	[a] Evaluate the importance of subjectivity and objectivity in a scientific explanation

7.3

GRADE 9	GRADE 10	GRADE 11	GRADE 12
[a] Identify uncertainties in a prediction	[a] State the role of uncertainty in predictions	[a] Determine if a solution associated with a science/technology/society problem is appropriate	

SOURCES OF INFORMATION

The following lists of professional journals, organizations, and resources are offered as a sampling of useful sources of information and assistance. This is not to be considered a comprehensive set of resources.

SCIENCE ACTIVITIES

- Activities for Teaching About Science and Society. Bybee, Peterson, Boyer and Butts. Charles E. Merrill, Columbia, OH, 1984.
- Idea - Centered Laboratory Science. Oakland Schools, 2100 Pontiac Lake Road, Pontiac, MI 48054, 1973.
- Project Learning Tree, The American Forest Council, 1250 Connecticut Avenue NW, Washington, DC 20036, Revised Edition 1986.
- Project Wild, Salina Star Route, Boulder, CO 80302, 1983.
- Science Concepts for Elementary Teachers: A Resource Guide. Don Mitchell, Southern Oregon State College, Ashland, OR, 1987.
- Science for Children: Resources for Teachers. National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418, 1988.
- Science Helper, K-8, Mary Budd Rowe. PCSIG, Inc., 1030 "D" E Duane Avenue, Sunnyvale, CA 94086, 1989. Computer application (CD-ROM) which contains almost 1,000 science and math lesson plans for K-8 from these projects:

  - SAPA Science: A Process Approach
  - COPES Conceptually Oriented Program for Elementary Science
  - SCIS Science Curriculum Improvement Study
  - ESSP Elementary Science Study Project
  - USMES Unified Science/Math for Elementary School
  - MINNEMAST Minnesota Math/Science
  - ESS Elementary Science Study

- Sciencing: Toward Logical Thinking. Darrel G. Phillips, Science Education Center, The University of Iowa, Iowa City, IA 52242, 1981.
- Unified Science Program: Curriculum Guide. Rex Putnam High School, 4950 SE Roethe Road, Milwaukie, OR 97267, 1985.

SCIENCE CURRICULUM CONCEPT PAPERS. Oregon Department of Education, 700 Pringle Parkway SE, Salem, OR 97310-0290, 1989.

- Contributions of Piaget To Science Education
- Developing Science Education Goals
- The Nature of Elementary School Science

- The Place of Science-Technology-Society Issues In Science Education

- Understanding Concept/Process-Based Science Education

SCIENCE PROFESSIONAL ORGANIZATIONS AND JOURNALS

- American Association for the Advancement of Science
  1333 "H" Street NW
  Washington, DC 20005

  Science
  High School; weekly

  Science Education News
  High School; quarterly

  Science Books and Films
  High School; 5 times/year

- American Association of Physics Teachers
  5110 Roanoke Place, Suite 101
  College Park, MD 20742

  The Physics Teacher
  High School; 9 times/year

- American Chemical Society
  1155 16th Street NW
  Washington, DC 20036

  Chem Matters
  High School; 4 times/year

  Chemunity
  High School; 4 times/year

- Environmental Education Project
  Portland State University
  PO Box 751
  Portland, OR 97207

  Clearing
  K-12; 5 times/year

- National Association of Biology Teachers
  11250 Roger Bacon Drive, #19
  Reston, VA 22090

  The American Biology Teacher
  High School; 8 times/year

- National Earth Science Teachers Association
  c/o Science Department
  Lansing Community College
  419 N Capitol Avenue
  Lansing, MI 48901

  The Earth Scientist
  Middle/High School; 4 times/year

- National Science Teachers Association
  1742 Connecticut Avenue NW
  Washington, DC 20009

  Science and Children
  K-Middle School; 8 times/year

  Science Scope
  Middle/Junior High; 7 times/year

  The Science Teacher
  Middle/High School; 9 times/year

- Oregon Science Teachers Association
  PO Box 20096
  Keizer, OR 97307-0096

  The Oregon Science Teacher
  K-12; 5 times/year

Informal Science Education Centers

- Hatfield Marine Science Center
  Marine Drive
  Newport, OR 97365

- High Desert Museum
  59800 S Highway 97
  Bend, OR 97702

- Oregon Museum of Science and Industry
  4015 SW Canyon Road
  Portland, OR 97221

- Willamette Science and Technology Center
  PO Box 1518
  (2300 Centennial Blvd)
  Eugene, OR 97440

SCIENCE SAFETY

- Safety in the School Science Laboratory: Instructor's Resource Guide. U.S. Department of Health, Education and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, Division of Training and Manpower Development, Cincinnati, OH 45226, August 1977.

- School Science Laboratories: A Guide to Some Hazardous Substances. Council of State Science Supervisors. U.S. Consumer Product Safety Commission. (Superintendent of Documents, U.S. Government Printing Office, #C-83-1180) Washington, DC 20402, 1984.

SCIENCE TEACHING

- Focus on Excellence series
  A continuing series from the NSTA, offering brief portrayals of ten programs chosen as exemplary during the 1982 NSTA "Search for Excellence In Science Education." The monograms are:

- Science As Inquiry	Vol. 1, No. 1
- Elementary Science	Vol. 1, No. 2
- Biology	Vol. 1, No. 3
- Physical Science	Vol. 1, No. 4
- Science/Technology/Science	Vol. 1, No. 5

- Guide for Inservice Instruction: Science - A Process Approach. AAAS Commission on Science Education, 1333 "H" Street NW, Washington, DC 20005, 1967.

- The Learning Cycle and Elementary School Science Teaching. Renner, Marek and Staffork. Heinemann, Portsmouth, NH, 1988.

- Learning by Doing: A Manual for Teaching and Assessing Higher Order Thinking in Science and Mathematics. NAEP, ETS 1987 Report No. 17-HOS-80, Washington, DC.

- Learning in Science: The Implications of Children's Science. Osborne and Treyberg. Heinemann, Portsmouth, NH, 1985.

- Science for All Americans: Project 2061. AAAS Commission on Science Education, 1333 "H" Street NW, Washington, DC 20005, 1989.

- Stepping into Successful Science Teaching: Instructional Manual. Lewis, Ostlund, Langley Project #5669030. Edwards Aquifer Research and Data Center, SW Texas State University, San Marcos, TX 78666.

- Towards a Science of Science Teaching: Cognitive Development and Curriculum Demand. Shayor and Ader, Heinemann, Portsmouth, NH, 1981.

- The Year in School Science 1987: Students and Science Learning. NFSS, edited by Champagne and Horning. AAAS, Washington, DC, 1987.

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